With METALLURGICAL SUPPLEMENT.

# The Engineer.

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VOL. CLII.—No. 3942] LONDON: FRIDAY EVENING, JULY 31, 1931 [PRICE {WITH SUPPLEMENTS} ONE SHILLING BY INLAND POST 1s. 3d.

## PUBLIC NOTICES.

HEATING.

The Commissioners of His Majesty's Works, &c., are prepared to receive TENDERS before 11 a.m. on Thursday, 20th August, for INSTALLATION of HOT WATER APPARATUS at the Head Post Office, Leeds.

Drawings, specification, a copy of the conditions and form of contract,

Bills of quantities and forms for Tender may be obtained from the CONTRACTS BRANCH, H.M. Office of Works, King Charles-street, London, S.W. 1, on payment of One Guinea. (Cheques payable to the Commissioners, H.M. Office of Works.) The sums so paid will be returned to those persons who send in Tenders in conformity with the conditions. 7334

### Armstrong College,

NEWCASTLE-UPON-TYNE.

(IN THE UNIVERSITY OF DURHAM.)

COURSES for the PASS DEGREE of B.Sc. and the HONOURS DEGREE of B.Sc. in MECHANICAL, MARINE, CIVIL or ELECTRICAL ENGINEERING, MINING, METALLURGY, or NAVAL ARCHITECTURE. The curricula of the Pass Degree and the Honours Degree normally occupy periods of three and four years respectively, but candidates presenting evidence of sufficient previous training may be allowed to proceed to either Degree after two years' residence.

The engineering laboratories have recently been extended, and all Departments are equipped for advanced tutorial and research work.

Full particulars of the Courses may be had on application to

THE REGISTRAR,
Armstrong College,
Newcastle-upon-Tyne.

6289

### Hull Education Committee.

MUNICIPAL TECHNICAL COLLEGE.

ASSISTANT LECTURER IN MECHANICAL ENGINEERING.

An ASSISTANT LECTURER is REQUIRED in MECHANICAL ENGINEERING. Experience with Automobile or Aircraft Internal Combustion Engines will be a recommendation. Salary in accordance with the Burnham Scale.

Forms of application, obtainable from the undersigned on receipt of a stamped addressed foolscap envelope, must be returned to these offices not later than the 15th August.

R. C. MOORE,
Director of Education.

Education Offices,
Guildhall, Hull.
21st July, 1931. 7324

### The Queen's University of Belfast.

VACANCY FOR JUNIOR ASSISTANT IN DEPARTMENT OF CIVIL ENGINEERING.

PARTICULARS.

1. The appointment is for one year, renewable for a period of three years.
2. The duties are chiefly to superintend drawing and design classes, to instruct in surveying class and field work, and to assist generally in the work of the Department under the direction of the Professor.
3. The salary is £250 per annum, for three terms of about 12 weeks each.
4. Candidates must hold a University Degree in Engineering.
5. Facilities will be given for advanced and research work in the Department.
6. Applications and copies of testimonials must be sent to PROFESSOR HUMMEL, Queen's University, Belfast, on or before September 1st, 1931. 7287

CITY OF

### Worcester Education Committee.

VICTORIA INSTITUTE SCIENCE AND TECHNICAL SCHOOL.

REQUIRED in September, a FULL-TIME ASSISTANT MASTER to TEACH PRACTICAL METAL and WOODWORK and ENGINEERING SUBJECTS in Day and Evening Classes. Applicants should hold a University Degree in Engineering and have had practical workshop experience.

Further particulars and application forms may be obtained from the undersigned on receipt of stamped addressed envelope.

F. E. CHANDLER,
Secretary for Education.

Tudor House, Worcester. 7325

### City of Nottingham.

WATER DEPARTMENT.

ELECTRICALLY DRIVEN MULTI-STAGE BOOSTER PUMPS AT SELSTON AND NORMANTON-ON-THE-WOLDS, NOTTS.

The Water Committee invite TENDERS for the SUPPLY and ERECTION of PUMPING PLANT, consisting of Electrically Driven Multi-stage Centrifugal Booster Pumps, Electric Motors, and other appurtenant Work, in the Parishes of Selston and Normanton-on-the-Wolds, Notts.

Copies of the general conditions of contract, specifications, schedules, bills of quantities and forms of Tender may be obtained on application to Mr. F. W. Davies, Engineer and General Manager, Water Department, Castle Boulevard, Nottingham. Applications for each scheme must be accompanied by a cheque for Three Guineas, which will be refunded on receipt of bona fide Tenders and the return of all documents.

Sealed Tenders, in separate envelopes endorsed "Tender for Booster Pumps, Selston," and "Tender for Booster Pumps, Normanton-on-the-Wolds," must be delivered to me at my office not later than 17th August, 1931.

By Order,
W. J. BOARD,
Town Clerk.

Guildhall, Nottingham,
20th July, 1931. 7282

## The Engineer

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## PUBLIC NOTICES.

### County Borough of Swansea.

MAIN DRAINAGE SCHEME.

CONTRACT No. 8.—WORKS FROM MUMBLES HEAD TO BRYNMILL.

The Corporation invite TENDERS for the CONSTRUCTION of SEWERAGE WORKS approximately as follows :—

| | | |
|---|---|---|
| 765 Yds. | Lin. | Twin 60in. dia. Cast Iron Pipes in Sea Outfall across foreshore. |
| 695 | .. .. | Storage Tanks, Four Tanks abreast, each tank approx 16ft. 6in. wide by 10ft. high, in tunnel in Mumbles Hill (limestone), lined in blue brick and concrete, including Penstock and Screening Chambers. |
| 1200 | .. .. | Brick and Concrete Ovoid Sewer, 7ft. 9in. by 5ft. 2in., in trench. |
| 3042 | .. .. | Brick and Concrete Ovoid Sewer, 7ft. 6in. by 5ft., part in tunnel. |
| 1980 | .. .. | Brick and Concrete Circular Sewer, 5ft. 6in. dia., in trench. |
| 44 | No. | Brick Manholes and Overflow Chambers ; |

together with Cast Iron Syphons, Stream Diversions, Culverts, Foreshore and other incidental works.

The whole of the works are UNEMPLOYMENT RELIEF WORKS, and will be subject to certain conditions laid down by the Government Unemployment Grants Committee.

On and after the 5th August, 1931, plans may be seen and specification, form of Tender, bills of quantities and a set of selected drawings obtained, at the Office of the Chief Engineer, Mr. J. Richard Heath, Guildhall, Swansea, on deposit of Ten Guineas, which will be returned on receipt of a bona fide Tender (not subsequently withdrawn), together with the specification, bills of quantities, and set of drawings.

The documents and Tender, which must be enclosed in a registered envelope endorsed "Main Drainage, Contract No. 8," must be received by the undersigned not later than Twelve Noon on the 25th August, 1931.

The lowest or any Tender will not necessarily be accepted.

H. L. LANG-COATH,
Town Clerk.

Guildhall,
Swansea.
July, 1931. 7332

## PUBLIC NOTICES.

TO ENGINEERING CONTRACTORS.

### Newry Port and Harbour Trust.

NEWRY SHIP CANAL—IMPROVEMENT SCHEME.

The Joint Committee of Newry Urban District Council and Newry Port and Harbour Trust is prepared to receive separate TENDERS for the EXECUTION of the following CONTRACT WORKS, viz.:—

CONTRACT WORK No. 1.—Breastwork of Timber Sheet Piling to Toe of Outer Embankment.

CONTRACT WORK No. 2.—Rubble Toe, Filling and Pitched Slopes on River Side of Outer Embankment.

CONTRACT WORK No. 4.—Widening and Deepening of Newry Ship Canal (approximately 84,000 cubic yards).

CONTRACT WORK No. 6.—New Wharf and Strengthening of Quay Wall on West Side of Albert Basin (Steel and Timber Piling, &c.).

CONTRACT WORK No. 7.—General Repairs to Pitching on East and West Banks of Newry Ship Canal.

The contract drawings and specification have been prepared by Messrs. R. Ferguson and S. McIlveen, Consulting Engineers, 36, Scottish Provident Buildings, Belfast, and may be inspected at their offices by arrangement.

A copy of the contract documents comprising form of Tender, form of agreement, conditions of contract, specification, bills of quantities and schedule of prices for each of these works may be obtained from the undersigned on payment of a sum of Five Guineas, which will be returned on receipt of a bona fide Tender. No Tender shall be retracted or withdrawn during three calendar months from date on which it is received.

The Tenders (which should be sealed and endorsed "Tender for Newry Ship Canal—Contract Work No. ....), will be received by the undersigned up to Twelve o'clock Noon on Monday, the 31st day of August, 1931.

The acceptance of a Tender will be subject to the approval of the Ministries of Finance and Commerce for Northern Ireland.

The lowest or any of the Tenders may not necessarily be accepted. Firms tendering must be responsible for all expenses incurred incidental to the preparation of their Tenders.

W. M. CRONIN (Town Clerk),
Hon. Sec. to the Joint Committee.

Town Clerk's Offices,
Town Hall, Newry,
24th July, 1931. 7298

## PUBLIC NOTICES.

### Bombay, Baroda and Central India Railway Company.

The Directors are prepared to receive up to Noon on Wednesday, 19th August, TENDERS for the SUPPLY of—

1. HELICAL and VOLUTE SPRINGS.
2. TYRES for LOCOMOTIVES.
3. COPPER FIRE-BOX PLATES.
4. STEEL BOILER FLUE and ARCH TUBES and STEAM PIPES.

Tenders must be made on forms, copies of which, with specification, can be obtained at these offices on payment of 10s. each (which will not be returned).

The Directors do not bind themselves to accept the lowest or any Tender.

S. G. S. YOUNG,
Secretary.

Offices : The White Mansion,
91, Petty France, Westminster, S.W. 1.
28th July, 1931. 7335

### County Borough of Swansea.

SEWERAGE AND DRAINAGE DEPARTMENT.

MAIN DRAINAGE SCHEME, CONSTRUCTION OF MAIN TRUNK SEWER, SEA OUTFALLS AND STORAGE TANKS, &c.

APPOINTMENT OF RESIDENT ENGINEERS AND CLERKS OF WORKS.

The Council invite APPLICATIONS for the following TEMPORARY APPOINTMENTS :—

(A) SENIOR RESIDENT ENGINEER : salary at the rate of £700 per annum.

(B) ASSISTANT RESIDENT ENGINEER ; salary at the rate of £500 per annum.

(C) THREE CLERKS of WORKS ; salary at the rate of £7 per week each.

The duration of the works will be for a probable period of three years, and the above appointments will be determinable by one month's notice on either side.

Applicants for the appointments under (A) and (B) must have undergone a regular course of engineering training and be thoroughly experienced in the duties of Resident Engineer, as applied to Sewerage Works of considerable magnitude carried out under contract.

Applicants for the appointments under (C) must be thoroughly trained Clerks of Works, experienced in Sewerage Works, involving large-sized Brick and Concrete and Cast Iron Constructions.

It is essential that applicants for all the above appointments shall have had considerable previous experience in important Main Drainage Works, involving Sea Outfalls and large Tunnelling Operations.

Applications must be made on forms to be obtained from Mr. J. Richard Heath, Chief Engineer, Main Drainage Scheme, Guildhall, Swansea, to whom applications shall be addressed, endorsed "Resident Engineer," or "Clerk of Works," as the case may be, and be received not later than the first post on the 18th August, 1931.

H. L. LANG-COATH,
Town Clerk.

Guildhall, Swansea,
20th July, 1931. 7297

### Doncaster District Drainage Board.

APPOINTMENT OF ENGINEER.

APPLICATIONS are INVITED for the POSITION of ENGINEER to the Board from engineers having Land Drainage Experience.

The salary offered is £800 per annum. Office accommodation and staff will be provided by the Board.

Particulars of the duties may be obtained upon application to the undersigned.

Applications, endorsed "Engineer," stating qualifications and accompanied by not more than three recent testimonials, must be received by the undersigned not later than the 17th August, 1931.

Canvassing will be a disqualification.

A. BEBBINGTON,
Clerk to the Board.

Winchester House,
Scot-lane,
Doncaster. 7323

### River Severn Catchment Board.

APPOINTMENT OF ENGINEER.

APPLICATIONS are INVITED from engineers experienced in Land Drainage, River (Tidal and Non-tidal) Embankments, and Sea Defence Works, for the APPOINTMENT of ENGINEER to the River Severn Catchment Board. The person appointed will be required to devote his whole time to the duties of the office, and the appointment will be determinable by three months' written notice on either side.

The salary will be at the rate of £1000 per annum, plus travelling expenses, and office accommodation and clerical assistance will be provided.

Canvassing, either directly or indirectly, will disqualify.

Applications, stating age, experience, and qualifications, with copies of not more than three recent testimonials, must be forwarded to me endorsed "Severn Catchment Board," not later than Saturday, 22nd August, 1931.

C. H. BIRD,
Acting Clerk of the Board.

Shirehall, Worcester,
27th July, 1931. 7322

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## PUBLIC NOTICES

**Abergele and Pensarn Urban**
DISTRICT COUNCIL.
ABERGELE AND PENSARN SEWERAGE.
APPOINTMENT OF CLERK OF WORKS.

The Council REQUIRE the SERVICES of an ENGINEER, to act as CLERK of WORKS, in connection with the Construction of about 370 Yards of 21in. diameter Cast Iron Pipe Sea Outfall Sewer and about 1200 Yards of 30in. to 9in. diameter Concrete Tube or Stoneware Pipe Sewers, together with Rising Main, Pumping Station, and the Incidental Works in connection therewith.

Applicants must be fully qualified by actual experience in similar work, and must be competent in the use of the level and theodolite and able to set out, test and measure up the works and check accounts.

The salary will be at the rate of £364 per annum, and, subject to satisfactory service, the appointment will be for the period of the construction of the works, which, it is estimated, will occupy at least nine months.

The person appointed will be required to act under the instructions of the Council's Consulting Engineer, Mr. Robert Green, M. Inst. C.E., 37, Bennett's-hill, Birmingham, from whom applicants can obtain a copy of the prescribed form of application, which must be filled in and delivered to me not later than the 3rd August, 1931.

JOHN R. WILLIAMS,
Solicitor and Clerk to the Council.
Town Hall, Abergele, North Wales,
16th July, 1931. 7294

**Somerset Rivers Catchment**
BOARD.
APPOINTMENT OF ENGINEER.

APPLICATIONS are INVITED from qualified ENGINEERS with experience in Tidal and Non-tidal River and Land Drainage Works generally. Salary £800 per annum and travelling expenses. Offices and staff, with an official residence, for which rent must be paid, will be provided. The person appointed will be required to devote the whole of his time to the duties of the office.

Applications, endorsed "Engineer," stating age and experience, together with copies of not more than three recent testimonials, should be sent to the undersigned not later than the 15th August, 1931. Canvassing in any form will be a disqualification.

(Signed) THOS. BARRINGTON,
Clerk to the Board.
King's-square, Bridgwater. 7344

**The Civil Engineers Appointments** BOARD, 8, Princes-street, Westminster, S.W. 1, acting under annual licence from the London County Council, invites INQUIRIES from EMPLOYERS SEEKING the SERVICES of PROFESSIONAL ENGINEERS, either as Assistants or in more responsible positions.

All those whose names are accepted for entry in the Board's Register for employment possess qualifications which have been attested by means of scientific examinations, practical training and experience. P1305

## SITUATIONS OPEN.

COPIES OF TESTIMONIALS, NOT ORIGINALS, UNLESS SPECIFICALLY REQUESTED.

TO ADVERTISERS UNDER BOX NUMBERS IN THIS CLASSIFICATION.

For the benefit of applicants, the Proprietors are prepared to insert brief notices that vacancies are filled, upon receipt of notifications from the Advertisers. These notices (limited to one line) will be free of charge and co-operation is asked for.

BOMBAY.—ENGINEER WANTED IMMEDIATELY as SALESMAN for Industrial Power Plant. Good technical knowledge essential and previous Indian experience preferred.—Address, stating age, qualifications, and salary required, 7350, The Engineer Office. 7350 A

BRUSHES.—WANTED, WORKS MANAGER for old-established Factory. Must be man of tact and initiative, experienced in the trade and capable of getting his own way.—Particulars and commencing salary in strict confidence to Box ZR 800, c/o Deacon's Advertising Offices, Fenchurch-avenue, E.C. 3. 7308 A

CRANE ENGINEER for New Works in the Midlands, with first-class designing experience combined with outstanding business ability.

Must be able to control a large staff and produce structural and mechanical designs so economical—yet thoroughly reliable—as to secure orders against the strongest competition.

Good theoretical knowledge, not necessarily high mathematical attainments, which has been thoroughly tried out in practice, essential.

To the right man a substantial salary will be paid.

Give full particulars of experience, which will be treated in strict confidence, and state age, which should be about 40, salary expected, and when at liberty.
Address, 7319, The Engineer Office. 7319 A

GRINDING WHEEL SALESMAN, for London District. Man with live connection. Own car an advantage, but not essential. Would consider man representing non-competitive lines.—Address, P1363, The Engineer Office. P1363 A

INDIA.—MECHANICAL ENGINEER, Age 25 to 30, single man with Public School education and Engineering Degree, REQUIRED by Engineering Firm of standing in India. Applicants must have special knowledge of Machine Shop Production Methods, coupled with a first-class knowledge of Modern Foundry Practice. Drawing-office experience and control ability essential. Good prospects.—Write, with full particulars of experience and copies of any testimonials available, to Z.F. 383, c/o Deacon's Advertising Offices, Fenchurch-avenue, E.C.3. 7339 A

SALESMAN DEMONSTRATOR for Arc Welding Electrodes and Portable Electric Tools REQUIRED. Salary and commission.—Address, P1343, The Engineer Office. P1343 A

DRAUGHTSMAN, Having Sound Experience in the Design and Details of Large Elevating and Screening Plants, WANTED.—Apply, W. J. JENKINS and CO., Ltd., Beehive Works, Retford, Notts. 7342 A

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YOUNG MECHANICAL DRAUGHTSMAN REQUIRED for Handling Plant design. State age and full particulars of practical and technical qualifications.—Address, 7347, The Engineer Office. 7347 A

## SITUATIONS WANTED.

A B.Sc., London University T. & T. (Electrical), matriculated Public School, aged 20, industrious and inventive, DESIRES POST in which work and brains will ensure advancement.—R., Box 534, Erwoods Ltd., 30, Fleet-street, London, E.C. 4. P1338 B

ELECTRICAL and MECHANICAL ENGINEER DESIRES APPOINTMENT. Practical, theoretical, commercial; keen, conscientious, tactful; over 20 years with one of largest engineering groups. Excellent directors' references. Exceptional all-round experience.—Address, P1359, The Engineer Office. P1359 B

## SITUATIONS WANTED (continued).

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Address, P1360, The Engineer Office. P1360 B

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YOUNG METALLURGIST, 1st-class Honours, B.Sc. (Metallurgy), REQUIRES POSITION.
Address, P1315, The Engineer Office. P1315 B

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## MISCELLANEOUS.

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P1290 I

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**For continuation of Small Advertisements see page 60.**


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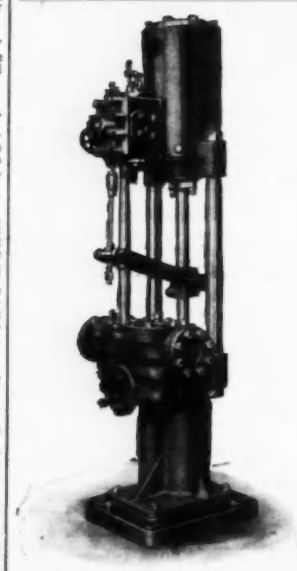

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See Displayed Advt. July 24th.

**The Metallurgist**

"The Metallurgist" is a free supplement accompanying the last issue of "The Engineer" for each month.

It is devoted entirely to the science and practice of Metallurgy—ferrous and non-ferrous.

The following comments by a few of our readers indicate its usefulness in a field hitherto much neglected.

"The supplement is very well arranged and will be of considerable value to the Metallurgical Industry."—Sheffield, February, 1925.

"The advantages gained by the metallurgist and the engineer through closer contact is obvious and your supplement should aid in this...."—Washington, U.S.A., February, 1925.

"... Metallurgical Supplement is undoubtedly very good."—Manchester, January, 1926.

"The Metallurgist is indeed a very splendid paper."

"... the high standard of these supplements which falls into a No Man's Land Land between research workers and users...."—Birmingham January, 1927.

"... supplements which are of a high order and very interesting."—Newcastle, January, 1927

# A Seven-Day Journal

## The "British Exhibitor."

IN a Journal note of July 10th we referred to the fitting out of the "British Exhibitor" as a floating exhibition of British goods and manufactures. On the afternoon of Wednesday last, July 29th, at 4 p.m., the naming ceremony of this ship was performed by Lord Derby at Cammell Laird and Co.'s Birkenhead yard. The "British Exhibitor" is the reconditioned "Leicestershire," late of the Bibby Line. She has a measurement of over 8000 gross tons, a speed of 15 knots, and has been equipped with 500 exhibition stands, with 6ft. gangways. Half the space in the ship has already been booked, and over £15,000 has now been paid for passage money and stand space. About 350 British firms are to be represented on the ship, and there will be a strong section specially devoted to shipbuilding and marine engineering exhibits and general ship equipment. She is scheduled to arrive in the Thames on August 25th, and will berth at Victoria Dock, where she will remain on view to the public until she sails on November 1st for a year's cruise to the Pacific Coast of North America, to Central America and the West Indies, and to all South American ports. Another trip has been planned to take place in a year's time to India and the Far East with a second ship, while a third ship is to be ordered, and a fourth is expected to follow. The office of the National British Exhibition Ship, Ltd., which is arranging these cruises, is at Bush House, London, and Lord Auckland is the chairman of the company. Captain H. W. Edwards, late R.N., is the commander of the "British Exhibitor."

## The National Gas Council and the Railway Electrification Scheme.

AT the annual luncheon of the Central Executive Board of the National Gas Council at the Savoy Hotel last Monday, Sir David Milne-Watson, President of the Council, criticised the main line electrification scheme. He said that as soon as the report of the Committee had been issued it had been examined to ascertain the probable effect of the scheme upon the gas industry. It had been found that there was nothing in the report which led to the expectation of any reduction in transport charges generally. The estimated cost of the scheme was £340,000,000, £80,000,000 of which was to be provided by the Central Electricity Board. The railways would have to find £260,000,000. The annual saving estimated in the report was £17,500,000, equivalent to a return on the capital expenditure of the railways of 6·7 per cent. Little margin, therefore, would be left for effecting any reduction in transport costs. At the same time the sum of £340,000,000 did not provide for the electrification of sidings, without which the scheme would be incomplete. Continuing, Sir David Milne-Watson said that everyone was more or less agreed on the advisability of electrifying suburban lines, but the question before the country was not one of suburban traffic only, but of main line haulage. The speed of our steam-driven trains already compared favourably with that of continental trains, and it was difficult to see wherein lay the advantage of electrification. After comparing the estimated expenditure on the national electricity grid with the probable considerably higher actual expenditure, he asked whether confidence could be placed in the estimated cost of electrifying the railways. Assuming, however, that the estimated cost was not exceeded, he asked what advantage would accrue to the nation, and pointed out that the estimated reduction in the consumption of coal by the railways of 9,750,000 tons would, it was understood, necessitate the permanent unemployment of 45,000 miners.

## Dock and Harbour Dues.

THE Traders' Co-ordinating Committee on Dock Charges, which is a body representing shipping, engineering, mining, industrial and agricultural interests, has had under its consideration for some time the continued high level of dock and harbour dues and other charges at United Kingdom ports, and has now prepared a memorandum reviewing the position since 1922. The Committee points out that although important reductions in dock charges took place at many ports in 1923, there have, with one or two exceptions, been no reductions of any importance in dues on ships during the last seven or eight years. In this period material changes have taken place in wholesale prices, in shipping freights, and in other factors which affect the industrial prosperity of the country. Over this period the average charges at United Kingdom ports show very little change, whereas in the same period wholesale prices have fallen 34 per cent., shipping freights 33 per cent., and cost of living nearly 15 per cent. The Committee feels that sufficient stress has not been laid on the fact that there are, like sheltered trades and workers, sheltered undertakings, such as docks and harbours, and it sees no justification for continuing the present increased dues on ships. It seeks, therefore, to draw to the attention of the individual dock authorities—both public trust and railway companies—the absolute and immediate necessity, notwithstanding the statutory powers they may possess, to reduce the charges for their services, as the shipowners have reduced their charges and as shipbuilders and the manufacturers of iron and steel and other materials have also reduced the prices of their commodities. In the long run, the Committee holds, lower dues should pay for themselves by attracting trade and by probably increasing employment.

## Charing Cross Bridge.

WE have noted in these columns from time to time the progress of the discussions with regard to Charing Cross Bridge. A week ago we recorded that the London County Council had decided to place before Parliament a Bill for the construction of a road bridge according to scheme No. 6, subject to the Government providing 75 per cent. of the cost. The Government, however, has now decided that it is not prepared to renew this offer, and as a result, according to Sir Percy Simmons, Chairman of the Improvements Committee of the L.C.C., Charing Cross Bridge will not be built and Waterloo Bridge will be demolished without delay to make place for a new bridge to carry six lines of traffic. The reason for the Government's decision is given as the insufficient resources of the Road Fund and the large commitments for the building of roads and bridges throughout the country.

## Costs in the Shipbuilding Industry.

ON Thursday, July 23rd, a joint conference of the Shipbuilding Employers' Federation and the shipyard trade unions was held at Carlisle, in order to discuss the employers' proposals for more economic costs of production and working conditions. The conference considered on behalf of both sides the result of the local conferences which had taken place since the last national conference on the subject of district excesses over the national uniform rates. It also dealt with the result of the National Joint Committee, which was set up to consider the detailed application of the employers' proposal with regard to the position of men other than plain time workers. It was stated by the union representative that the men's side of the conference had decided unanimously that reductions in wages could not be accepted. After an adjournment, it was stated by the employers that in view of a settlement not being reached, the original wage proposals must stand, and that they would be applied as from the first full pay-day in September. The union representatives replied that they would report the employers' intimation to their respective executives in accordance with the recognised joint wages procedure, when the parties had failed to reach an agreement. The conference therefore stands adjourned, and arrangements have been made for the parties to meet again on Thursday, August 20th, at Carlisle.

## The Bartley Reservoir Report.

A REPORT on the condition of the Bartley reservoir was recently presented to the Birmingham Water Committee, and a statement on it was made by Alderman E. Martineau, the Chairman of the Water Committee, at the City Council meeting, which took place on Wednesday last, July 29th. The report has been prepared by Professor Boulton, Mr. Hill, Dr. Lapworth and Mr. Macaulay, and deals with the escape of water which was observed when the reservoir was filled, and which has been under investigation by the expert engineers above named. The evidence of the various bore-holes which have been made denotes, in the opinion of the consultants, the existence of what appears to be a relatively narrow disturbed or faulted belt in the 20ft. seam of pervious rock which passes under the north arm trench, near its junction with the main trench, and runs outward almost due north from the reservoir. There appears to be no indication that any leakage is taking place through any portion of the dam or other part of the reservoir construction. The consultants recommend that a number of bore-holes should be sunk and cemented, chiefly into the disturbed portion of the area and to either side of it, and the Water Committee has authorised procedure on these lines.

## The New N.G.I. Liner "Rex."

PARTICULAR interest attaches to the new liner "Rex" of the Navigazione Generale Italiana Line, which, it is expected, will be launched this week from the Sestri Ponente Yard of the Cantiere Navale Ansaldo, Genoa. She has been specially designed and built under the survey of Lloyds' Register of Shipping and the Registro Italiano ed Aeronautico, for the company's express service between Genoa and New York. Her length is 268·25 m., or slightly over 880ft., while her maximum beam is 31 m., or about 101ft. 6in., and her measurement over 50,000 gross tons. She will be propelled by four independent sets of high-pressure geared turbines, the machinery being so grouped in different watertight compartments that in the event of damage at least two sets of turbines, with their auxiliary machinery, will be available for propulsive and auxiliary services. Superheated steam will be supplied from fourteen water-tube boilers and the turbines have been designed for a sea speed of over 27 knots. Provision is to be made for more than 2300 passengers in four classes, while the officers and crew will number about 800 persons, making a total ship's complement of over 3000. The "Rex" has a raking bow and an elliptical stern, and six of her eleven decks extend the whole length of the ship. The subdivision of the hull has been so arranged that buoyancy is ensured when three adjoining compartments of the fifteen are flooded, while navigability will be possible with two adjacent compartments flooded. A similar liner, the "Conte di Savoia," is under construction for the Lloyd Sabaudo Line at the San Marco yard of the Cantieri Riuniti dell'Adriatico Trieste, and is now rapidly approaching her launching stage.

## The Nile Waters.

ACCORDING to the Nairobi correspondent of *The Times*, a photographic survey of the Lake Albert area in Africa is being carried out by the Aerial Survey Company. It is being made as part of a big engineering scheme to eliminate the Nile sudd and provide Egypt and the Sudan with an additional water supply. The area under survey is that lying 20 miles on each side of the Nile between Nimule and Lake Albert, and a strip of about the same width around the lake itself. The importance of the survey lies in its relation to the Nile waters schemes. Estimates have been made that no less than two thirds of the water flowing into the Nile from Lake Albert are wasted in the sudd area. In consequence, two projects have been put forward. One favours the cutting of a channel through the sudd, and in the other the suggestion is made that a canal should be constructed to divert the waters away from the sudd area. The second scheme is regarded as almost out of the question on the score of expense, while it has so far been found very difficult to obtain the necessary data for preparing plans to carry out the first project. It is hoped that the aerial survey will provide the data required. If carried out, the scheme will involve the building of a great dam at Pakwach on Lake Albert, which would raise the water level 25ft., and enable the initial source of the waters to be controlled. A road also would be built from Pakwach to Juba along the west bank of the Nile.

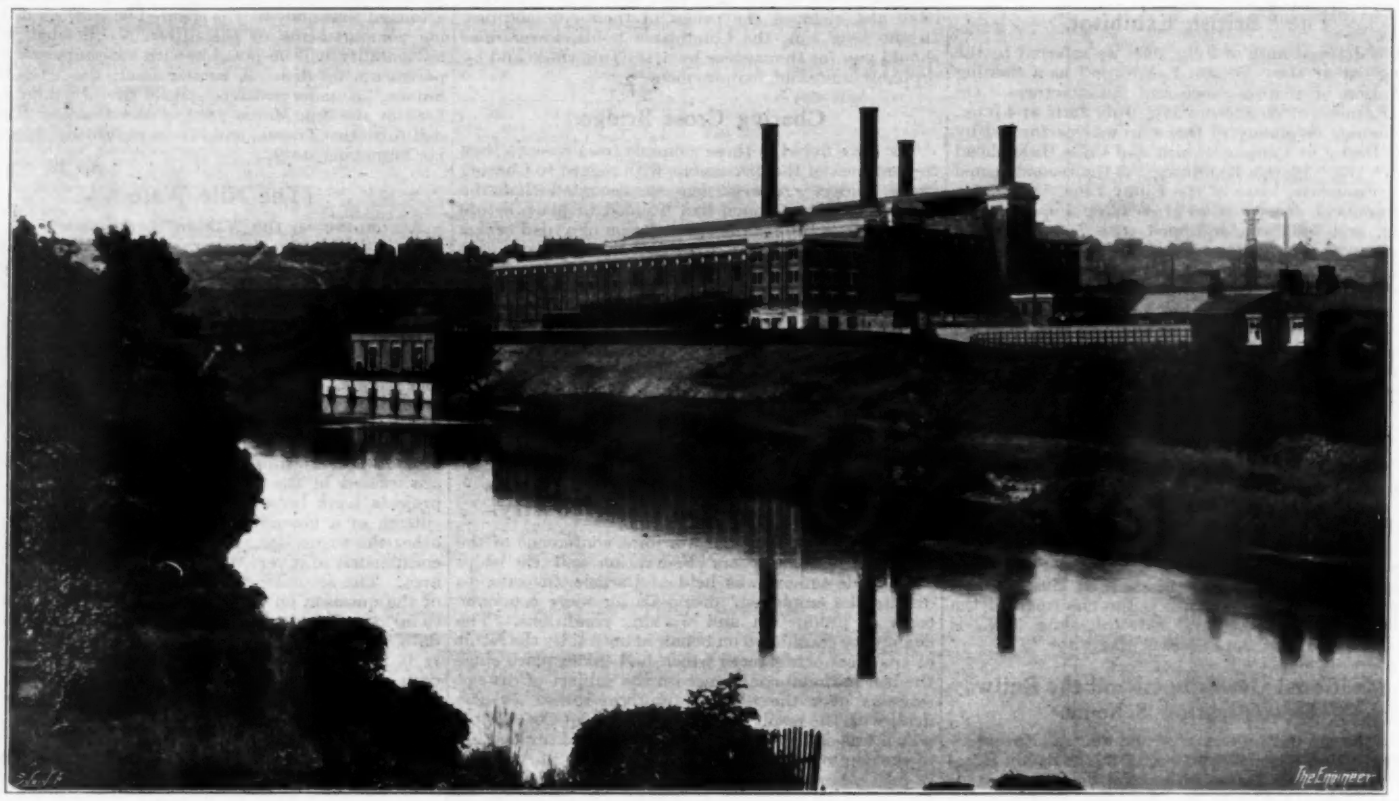
## The King's Cup Air Race.

IN unfavourable weather last Saturday the King's Cup Air Race was won by Flying Officer E. C. T. Edwards, in Sir Robert McAlpine's Blackburn Bluebird aeroplane, fitted with a Cirrus Hermes I. engine of 110 horse-power. His average speed was 117·8 m.p.h. Since professional pilots were excluded from participating in the race, it was generally expected that the average performance would be lower than it has been in recent years. In actual fact, however, although the highest speed was somewhat slower than that of last year, the average performance was between 10 and 12 m.p.h. faster. Under the watery conditions existing at the time, with a wind velocity ranging between 15 and 20 miles an hour, low clouds, and heavy rainstorms occurring frequently and limiting vision to about half a mile, the general performance can be regarded as satisfactory. Of the field of forty which started twenty-two finished the course, the remainder falling out at intervals owing to the bad weather conditions, minor failure of some part of their machines or engines, or through inability to find the way. At Liverpool, little more than halfway round, only twenty-three were left in the race, but all of them, save one, finished. Twelve purely amateur pilots completed the course, the remainder being serving or former R.A.F. officers.

## Profit-Sharing in 1930.

DURING 1930 there were 491 undertakings of all kinds practising profit-sharing in Great Britain and Northern Ireland. Eight of the concerns, says the report issued by the Ministry of Labour, had two distinct schemes, the number of separate schemes thus totalling 499. Approximately 238,000 workpeople, out of about 500,000 employed, were eligible to participate in the benefits. No returns were made to the Ministry in the case of 77 schemes, the remaining 422 schemes providing an average bonus of £9 18s. 4d., or an addition to earnings of 5·6 per cent. Compared with the preceding year, these statistics show a decrease of eight known schemes with 22,000 participants, in operation; while there were increases of three schemes making returns, with an increased average bonus of 8s. 3d., which, however, showed a decreased addition to wages of 0·8 per cent. In businesses other than co-operative societies there were 329 schemes in operation at the end of 1930 The 321 firms associated with these schemes employed approximately 467,200 workpeople, of whom 205,200 were participants. In the metal, engineering, and shipbuilding group, 47 schemes, organised by 44 firms, were in operation at the end of the year. Approximately 21,100 workpeople were entitled to participate out of a total of 79,600 employees engaged. In the case of 31 schemes in this group, with 18,000 participants, an average bonus of £4 9s. 1d. was declared, giving an addition to earnings of roughly 3·6 per cent. Of the four new schemes included in the Ministry's report, two are connected with insurance businesses, one with gas manufacture, and one with a firm of motor engineers. During 1930 eight schemes were known to have been discontinued.

# THE KEARSLEY POWER STATION OF THE LANCASHIRE POWER COMPANY



## The Kearsley Power Station.

No. I.

WHEN the Lancashire Power Company announced its intention of building a new power station at Kearsley, particulars of its design were awaited with a special eagerness. That its performance was likely to be an exceptional one was a foregone conclusion, for its antecedent stations had shown that the company was fortunate in the possession of designing and operating engineers of the very first order. The earliest station of the company—that of Radcliffe—had always maintained a wonderful record of efficiency since it was put into service in 1905. Working with a steam pressure of only 150 lb. and a temperature as low as 500 deg. Fah., it had, nevertheless, held a most honourable place until quite recent years amongst public power stations, for its production of a kWh of saleable energy for a coal consumption of 1·75 lb. or less. Then, in 1927, the second station of the company—at Padiham—was brought into commission, and immediately leapt into fame by surpassing in efficiency every other power station in the country. The feat was all the more remarkable in that Padiham possessed none of the special characteristics believed by many people to be essential to the highest efficiency. The station was a small one, with an annual output of only 67 million kilowatt-hours, thus ranking only forty-seventh in point of size among all the three hundred plants to which it had proved itself superior. Its load factor of 42·5 per cent. was fairly good, but a long way from being the best. Very little importance, however, can be attached to load factor. A poor load factor often provides an all-too-easy excuse for a high fuel consumption, in spite of the fact that, within the range of power station practice, no necessary connection between the two has ever been demonstrated. Indeed, as we have several times pointed out, the linear relationship between fuel consumption and total output, characteristic of all power stations, precludes the existence of any such connection. Whatever, then, was the reason of Padiham's wonderful efficiency, it had nothing to do with load factor. Nor could it be ascribed to anything novel in the equipment. The boilers were of the old B & W land-type, with chain grate stokers and Green's cast iron economisers, and worked with natural draught at normal load. The steam conditions were very moderate, 250 lb. and 620 deg. Fah. only. There was no attempt at recuperation of heat by air heating. Nor were the turbines bled for regenerative feed heating. In fact, the list of all the modern requisites for economy which were not adopted at Padiham would shock those who think that efficiency is not to be obtained without following theory, regardless of the complications which it may involve. Yet, from the very first month of the station going into service, there were inexorable figures to confound the critics and to justify Mr. Adams and his staff. We need not say more of Padiham, for in our issues of July 20th and 27th, 1928, we described the station and its performance very fully, with a view to showing what results could be obtained on a very low capital expenditure by really good design and operation.

In getting out the plans for the new station at Kearsley, the company set itself, naturally, to beat its previous records at Padiham. Difficult as the task was, it has done it, and done it handsomely. Whereas Padiham, according to the Commissioners' returns, beat all other stations in the country with its thermal efficiency of 21·35 per cent., and its coal consumption of 1·33 lb. per kWh, Kearsley has improved on these results with corresponding figures of 23·84 per cent. and 1·17 lb. per kWh respectively. These figures are based, in each case, on a year's operation. The above results are computed on the gross output of the generators in accordance with the unfortunate practice employed by the Commissioners in compiling their annual returns. The true basis for stating efficiency is, of course, the quantity of saleable electrical energy leaving the station, for the power used up in the station itself is of no account commercially. It is manifestly unfair that stations consuming a considerable proportion of the power generated in driving pulverising plant, fans and other auxiliary machinery should be credited with this amount of power as true output. Were the official figures of efficiency and coal consumption computed in the manner which the most enlightened station engineers maintain that they should be, neither Kearsley nor Padiham would have anything to fear, for, although the whole of the auxiliary machinery is, in both cases, electrically-driven, the power required for the services of the stations has, in both cases, been kept to a minimum.

In order that the merits of the performance of Kearsley may be better appreciated, we give, in Table I., below, some data relating to the ten British stations which head the list as regards efficiency :—

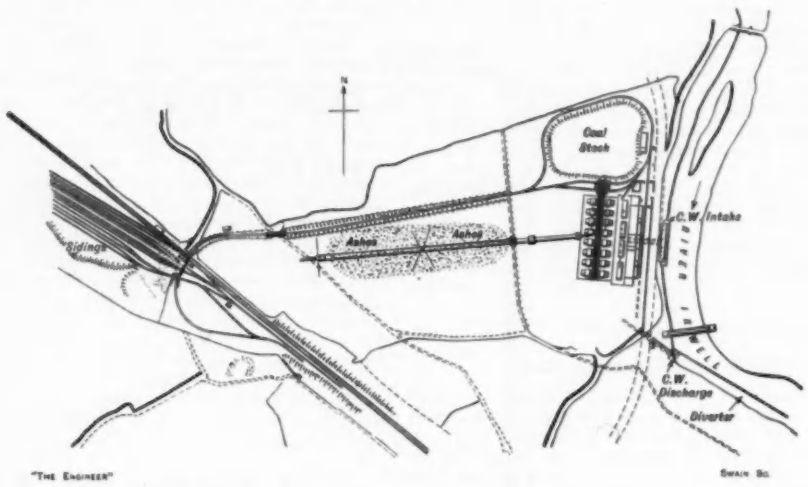



FIG. 1—SITE OF KEARSLEY POWER STATION

TABLE I.—*British Power Stations in Order of Thermal Efficiency.*

| Name of station. | kWh generated, millions. | Coal per kWh, pounds. | Thermal efficiency, per cent. | Annual load factor, per cent. |
|---|---|---|---|---|
| Kearsley .. .. .. | 129·6 | 1·17 | 23·84 | 42·3 |
| Deptford West .. .. | 280·8 | 1·29 | 23·20 | 43·3 |
| Barking .. .. .. | 543·3 | 1·38 | 23·02 | 37·2 |
| North Tees .. .. | 255·1 | 1·26 | 22·69 | 50·2 |
| Hams Hall .. .. .. | 133·6 | 1·46 | 22·50 | 34·6 |
| Barton .. .. .. .. | 402·9 | 1·31 | 22·23 | 41·7 |
| Ferry Bridge .. .. | 158·5 | 1·31 | 22·23 | 45·2 |
| Spondon .. .. .. | 126·2 | 1·51 | 21·93 | 46·5 |
| Bonnybridge .. .. | 50·2 | 1·48 | 21·48 | 52·5 |
| Portishead .. .. .. | 106·9 | 1·35 | 20·56 | 30·5 |
| Lister Drive No. 3 .. | 267·5 | 1·47 | 20·36 | 56·7 |
| Deptford East .. .. | 249·3 | 1·53 | 19·96 | 30·0 |

The figures in the table are interesting as showing

the theoretical disadvantages, as regards steam conditions, &c., under which Kearsley operates, as compared with its rivals. More interesting, however, for our present purpose is the comparison with Padiham. At Kearsley the steam pressure and temperature has been increased, and, as will be seen later, the land-type boiler has had to be abandoned on account of the increase in capacity required. Chain grate stokers, however, have been retained in preference to powdered fuel burners, although the possible dust nuisance with the latter could hardly be a dominant consideration in the open country where the Kearsley station is situated. Cast iron economisers are also adhered to, but air heaters and forced and induced draught are now provided. In the engine-room progressive feed heating has been adopted, but in two stages only, leaving plenty of work for the economisers to do.

The steam pressure at Kearsley is 315 lb. and the steam temperature 710 deg. Fah., as compared with the 250 lb. and 620 deg. Fah. of Padiham. With a 29in. vacuum in each case, the adiabatic heat drop per pound of steam has been increased from 442·2 to 477·7 B.Th.U., a matter of something over 8 per cent. The provision of regenerative feed heating at Kearsley, however, still further improves the heat cycle of the newer station. But the principal feature which characterises Kearsley as well as Padiham is the essential simplicity of the whole layout. In both stations the belief has been acted on that the simpler a plant is and the more easily the boilers are worked, the nearer will the efficiency approach what is theoretically possible. At Kearsley, for example, the chain grates are not asked to burn more than 23·8 lb. of coal per square foot, nor are the boilers themselves called on to evaporate more than 6·4 lb. of water per square foot of boiler heating surface, even at full load. At such ratings, a boiler-house efficiency averaging 83·8 per cent., or 82·2 per cent. after deduction of all auxiliary power, is maintained over a year's working; and that is done without automatic boiler control or any elaborate system of instruments, and with the minimum of supervision. The best answer to those who say that such low ratings unduly increase capital costs, is to quote the cost of Kearsley itself. The whole station, including some 42 acres of land, with new roads and railway sidings, was constructed for a total cost of £901,578—£14·1 per kW of installed capacity. That is a very low figure for a modern station, and it will, of course, be materially reduced when the plant is increased to its ultimate designed capacity. The cost, it may be added, was not forced down by severe competition, which is usually as unsatisfactory for the purchasers as for the manufacturers. The company knew what it wanted and what was a reasonable price to pay for it, so that it allotted the whole of the work to selected contractors at agreed figures.

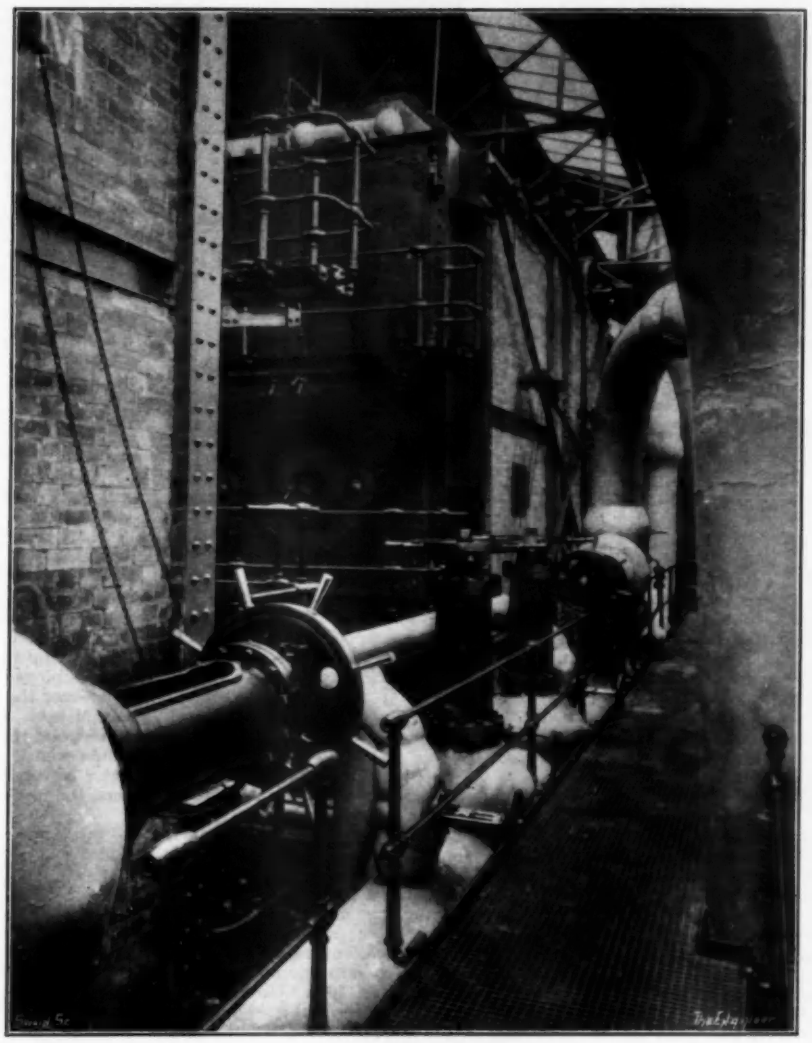


FIG. 2—STEAM RANGE OPERATING GALLERY

### THE POWER-HOUSE.

Before going further into questions of efficiency or cost, it will be well to describe the principal features of the station itself. The Kearsley station is situated in the southern part of the company's area, not far from the old station at Radcliffe. It is connected to Radcliffe by 33,000-volt cables, as it is, also, to Padiham, 20 miles to the north, and to the Barton station of the Manchester Corporation, 12 miles south. It was constructed to deal with the growing industrial demand for power, both in the company's area and in the townships which buy current in bulk from the company. The station stands on the bank of the river Irwell, from which both circulating water and boiler make-up water are obtained. Coal is brought in by rail.

The general appearance of the Kearsley station is shown in the engraving on the opposite page, and the layout of the site in Fig. 1. In the latter drawing the turbine and boiler-rooms are both shown twice their existing length, as the station was designed with a view to duplicating its present capacity in the future. Indeed, there is room for more than triplicating it by merely adding to the length should the need arise. The equipment at present consists of two turbo-alternators, each of 32,000 kW capacity, together with eight boilers to serve them. Confining ourselves for the moment to the exterior of the station, we note that coal is brought by rail to the sidings, shown in Fig. 1. The wagons are taken therefrom as required, and the empties returned by the power-house workmen. The work is performed by an electric locomotive, on the overhead trolley system, belonging to the company. The level of the siding being too much above that of the power-house to allow of a direct connection with a practicable gradient, it was necessary to lay the electric line on a detour, as shown, starting from the side of the main tracks furthest from the power-house, and passing under the sidings themselves on the way to the tipplers. By this means a maximum gradient of 1 in 28 was secured. Before being tipped, the coal trucks pass over one of a pair of weighing machines, and they are weighed again afterwards. The tipplers deliver the coal into hoppers beneath them, whence it can either be taken by an elevator into the boiler-room bunkers, or taken for the stock pile. The latter is formed by a drag scraper, by means of which one man can spread the coal evenly, tidily and uniformly as fast as it can be received. No better evidence of the efficiency of the scraper method is required than the appearance of the stock pile at Kearsley, which is perfectly level and solid enough, both to walk on with comfort and, apparently, to avoid all danger of heating. At any rate, no heating has yet been experienced, though the state of the pile is kept under observation by means of vertical iron rods piercing it from top to bottom at intervals. A view of the tippler-house and electric locomotive is given in Fig. 4 (Supplement). The end of the boiler-house can be seen at the left of the illustration, and the coal pile, with scraper controlling house at the right. The whole of the incoming coal passes over the weighing machines and is discharged by one or other of the tipplers into a hopper beneath. From this hopper it enters a bucket conveyor which takes it into the boiler-house. The conveyors, like the hoppers, are in duplicate. The coal which is not destined for immediate delivery to the bunkers is returned by the belt conveyor, seen above the tippler-house, and falls through a shoot at the end of the gantry into a position whence it can be taken away by the drag scraper and incorporated into the stock pile. The same drag scraper removes coal from the stock pile when needed and dumps it into a hopper, whence it falls into the boiler-house conveyors. The arrangements for sampling will be referred to later.

### ASH DISPOSAL.

The ashes are handled with the same economy of labour as the coal. In the boiler basement is a runway passing under all the ashpits. Suspended from the runway are steel skips, into which the ashes are dumped by opening the ashpit doors. The loaded skips are then pushed to the end of the basement, where the ashes in them are quenched. Their journey continues to the terminal of an aerial ropeway, just outside the boiler-house, illustrated in Fig. 5. Here, they are picked up by the ropeway and carried overhead, either to be dumped into a hopper for sale, or on to an ash pile. So far, there is no ash pile as the power station is in the fortunate position of being able to dispose of ashes for road-making as fast as they are produced.

### THE CIRCULATING WATER INTAKE.

The circulating water, as already mentioned, is drawn from the Irwell, which, especially at flood time, is not the cleanest of rivers. The intakes, illustrated in Fig. 6, are protected by iron gratings against the entrance of large objects. Leaves, straw, and other undesirable matter which can pass the gratings are prevented from reaching the pumps and condensers by Blakeborough rotating screens. The rubbish is arrested by the screens, and, after being lifted well above water level by their motion, is washed off continuously by water jets. It falls, along with the wash water, into a special channel, which conducts it back into the river downstream out of harm's way. The screened water passes to the suctions of two pairs of 20,000-gallon Worthington-Simpson centrifugal pumps, situated in the house, of which the wall can be seen in Fig. 6. The interior of the pump-house is shown in Fig. 7. Each pair of pumps delivers into a 36in. welded steel pipe going to one of the condensers in the engine-room. The valves on the discharge side of the pumps are hand-operated, but their control is rapid and easy, as roller bearings are incorporated in their construction. The two discharge pipes are very visible in Fig. 7. The smaller pipe above them is to enable a part of the warmed circulating water from the condensers to be delivered into the river just above the intakes. Thus, in times of hard frost, any trouble with ice at the screens can be avoided. The main circulating water discharge is taken by a single 54in. pipe to a point on the river bank 400ft. below the power-house. Arrangements have been made, however, whereby the point of discharge can be easily extended to the crest of a weir some 350 yards below the intake. Hence, there is no fear of any of the warmed water finding its way back to the intake, a common source of trouble if not guarded against.

The arrangement of the Blakeborough screens and pump-house machinery is more clearly shown by the drawing reproduced in Fig. 3. There are, altogether, five screens rotating in the same direction. The way the screens are driven is particularly worthy of notice. Driving is effected by means of a motor-driven friction wheel in contact with the rims of the screens. Four of the screens are driven in pairs, a single friction wheel engaging with two adjacent rims. For the fifth screen no such arrangement was possible, so that the friction wheel is held to its work by a roller. The friction drive fulfils its purpose admirably, while there is no possible risk of injury to the screens or the mechanism should anything happen to cause a screen to stick. The screen shafts turn in grease-filled water-tight roller bearings, and need no attention of any kind.

### THE STATION LAYOUT.

The present engine-room equipment comprises a pair of British Thomson-Houston turbo-generators, each of a maximum continuous rating of 32,000 kW at 1500 revolutions per minute, with house alternators and exciters on the same shaft. In the boiler-house alongside, are eight Babcock and Wilcox boilers

of the cross-drum marine type, designed for 75,000 lb. of steam each per hour at 305 lb. and 685 deg. Fah. The arrangement permits of a very narrow engine-room with ample space around the machines, and at the same time allows the plant to be extended to its ultimate capacity without departing from the simplicity and convenience of a single firing aisle. The switchgear is housed along the side of the turbine-room, furthest from the boiler-house, while, external to the main building altogether, are the transformers in their cubicles.

Each pair of boilers is served by a common chimney. The flue gases leaving the tops of each boiler are led to the back by a duct and pass downwards through a Green's cast-iron economiser, and a tubular air heater in series. The forced and induced draught fans are on the basement floor near to their respective chimneys, and under far better observation than such plant can be subjected to if it can only be reached by mounting to the top of the boiler-house. The boilers are set in brickwork, contrary to the practice in most modern power-houses, but justified by the experience of Padiham and Radcliffe. The setting is built up in a manner not unusual in continental power stations, but very uncommon in England. Externally, the setting has the appearance of a series of concave panels filling the spaces between vertical steel joists. The panels may be regarded as arches standing on end, with their concave sides outwards. Their curvature avoids expansion troubles, especially as they only touch the real walls of the furnace at their crowns, air spaces being left elsewhere.

The photograph of the firing aisle, reproduced in Fig. 8, shows how thoroughly well lighted the boiler-house is. Indeed, in the original of the engraving it is possible to discern the time indicated by the clock at the far end. Natural lighting is facilitated by the steep hoppers of the overhead bunkers, which can be seen in Fig. 9. The latter view also shows the kind of gallery flooring employed, the construction of which allows the maximum of light to pass through while ensuring a comfortable and secure foothold. The galleries, moreover, are wider than is usual, so that a man upon them can go about his work with ease. Fig. 10 is a view taken in the basement. Overhead is the hot air duct to the grates, and equally prominent in the engraving are the ashpit doors of one boiler. The shoots to the left are for the burned riddlings from the grates. The unburned riddlings falling from the front ends of the grates are raked out periodically on the boiler-room floor and thrown back into the stoker hoppers. The ashes and clinkers passing over the end of the grates are dumped from the large shoots on the right. The skips, to which reference has already been made, are hung from the runway between the shoots, and can receive either ashes or riddlings at will.

An automatic lift serves the boiler-house. It runs between the basement and the conveyor gallery, with stops at the firing floor and the gallery at boiler-drum level. On arrival at the top one can pass along the tops of the bunkers on a broad and comfortable wooden gangway, from which the bunkers can be levelled and the conveyors attended to with ease. As is well known, one of the nuisances of bucket conveyors is the difficulty of ensuring adequate lubrication of the rollers on which the conveyors run. At Kearsley a most ingenious lubricating device has been installed to meet the requirements. The roller pins are all drilled with axial oil-holes, and the ends of the pins are conical, the holes occupying the points of the cones. Fixed at one point of the conveyor framing is a cast iron box containing a mechanism operated automatically by the conveyor when desired. When in action, a small oil pump of the plunger type emerges from the casing and presses its end on to the conical end of the roller pin as it passes. The pump travels a little way along with the chain, discharging its oil into the pin meanwhile, and then is withdrawn and returned to its place in time to lubricate the following roller in the same way. When once set to work, the action is entirely automatic, and the whole chain can be properly and equally lubricated while it makes a single revolution. The device gives no trouble at all, and does its work with complete efficiency, materially reducing the maintenance cost of the conveyors.

Two other views in the boiler-room are illustrated in Figs. 11 and 2. The former is taken between a pair of boilers, looking towards the base of the chimney which serves them. On the extreme left is the end of one of the boiler settings, with an instrument panel, which will be referred to later. Beyond it is the setting of the economiser and air heater, while against the base of the stack are the motor control panels for the forced and induced draught fans. Fig. 2 is from a photograph taken from a gallery against the engine-room wall of the boiler-house, showing the backs of the economiser and air heater settings, and especially the main steam valves of the Blakeborough type. The width of the operating gallery and the handiness of the positions of the valves themselves are very noticeable.

*(To be continued.)*

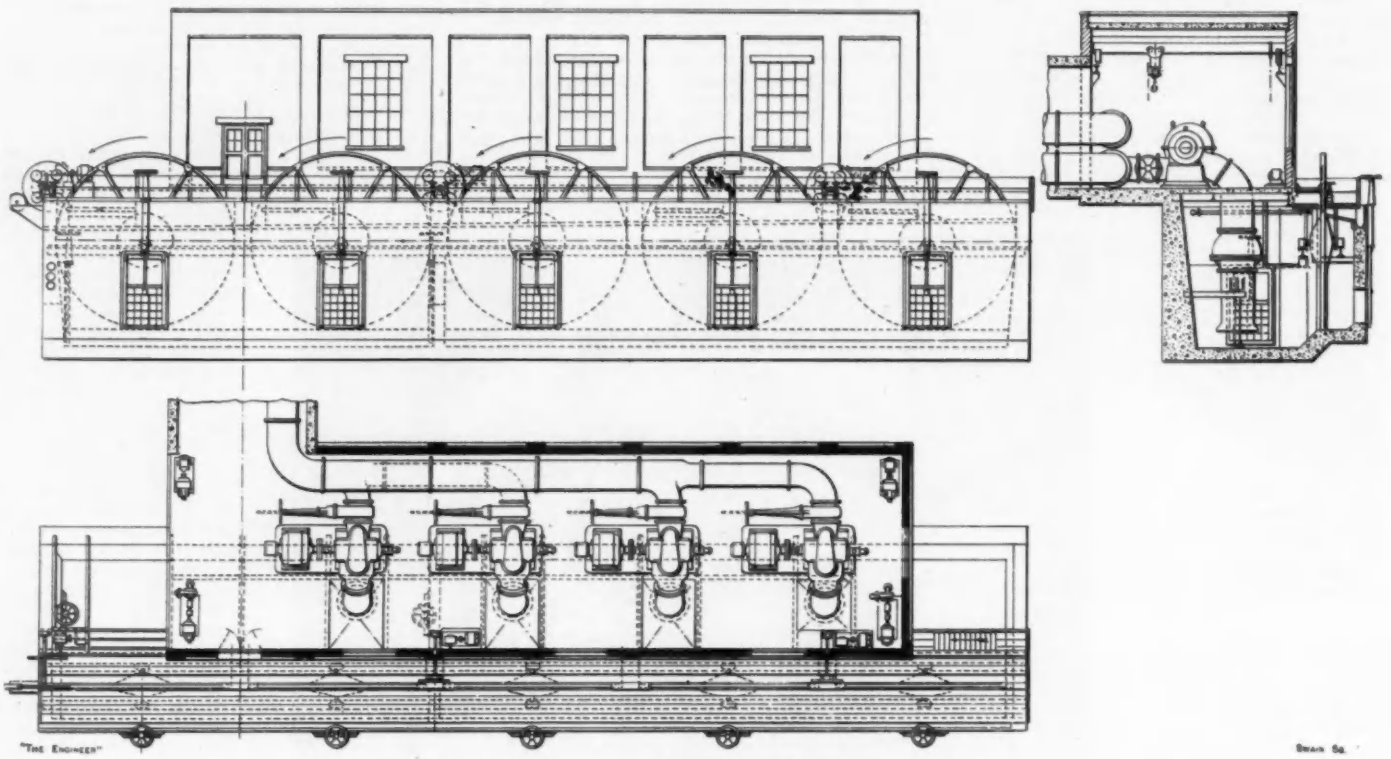


FIG. 3—BLAKEBOROUGH SCREENS AND PUMP HOUSE

## Geophysics.

No. I.

FROM the moment at which man first discovered that valuable materials could be found buried within the crust of the earth a search has been made for some method of predicting the position of such deposits without the need for laborious boring. In spite of the fact that geologists have collected a great knowledge of what is to be expected beneath the surface from the character of the ground above, the indications they can give are frequently insufficiently accurate to save a very considerable expenditure on the sinking of exploratory bore-holes. With the expansion during the last century of the needs of mankind the search for precision instruments capable of accurate sub-surface surveys became intensified, with the result that geophysical instruments have now been produced and a store of knowledge in connection with their use is being collected. Their application is still limited, and the meaning of the results obtained is sometimes open to doubt, but in the main, and given favourable conditions, these instruments have proved themselves relatively cheap and accurate.

For the purposes of geophysics use is made of a variety of the familiar properties of the materials forming the crust of the earth. For instance, it has been known for several centuries that highly magnetic materials could be discovered by the use of a magnetic needle. Knowledge of other properties of minerals, rocks, &c., has led to the development of methods employing variations in gravitational attraction, the speed of transmission of waves, such as those produced by earthquakes, and the distortion of electric fields by good and bad conductors beneath the surface of the ground. Latterly, attempts have been made to adapt Hertzian waves to the detection of deposits, and in the future, no doubt, other physical properties will be employed for this purpose.

Whatever the method adopted, it is obvious that a considerable stock of physical knowledge is first required, and this consideration determines the reason why the science of geophysics has only recently developed. Nevertheless, owing to its connection with others, the new science can trace its history far back into the past, and in recognition of this there are on show at the Geophysical Exhibition in the Science Museum at South Kensington examples of many ancient instruments. One of them is a drawing of a Chinese seismoscope invented by Choko in A.D. 136. It is reproduced in Fig. 1. From the sides of a circular box a number of dragons' heads project. In the mouth of each dragon a ball is delicately balanced. On the occurrence of an earthquake a ball is dropped from the mouth of one of the dragons into that of a chameleon crouching below to receive it. The

FIG. 1—CHINESE SEISMOSCOPE

orientation of the particular animals affected indicated roughly the direction from which the disturbance originated.

The development of the science of seismology was hardly rapid. As late as 1825 Niccolo Cocciatore introduced into Italy a seismoscope which consisted of a circular metal receiver. Holes were drilled through the sides and the box was filled to the level of the holes with mercury, which, on the occurrence of an earthquake, flowed out to be caught by an external cup at the base of the instrument. The particular hole and cup and the amount of the liquid displaced gave some indication of the direction of origin of the disturbance and its intensity respectively. In 1700 years that was the greatest improvement that man could devise on Choko's instrument.

As geophysical methods of survey depend upon the physical properties of the materials forming the ground, there must, if success is to be achieved, be some detectable contrast in, at least, one of their properties. In general it may be said that at present the majority of geophysical surveys are made with the object of locating some particular material which is known to exist in the neighbourhood, but of which the precise position is unknown. If the survey is to be successful, then, the properties of the material must differ from those of the adjacent strata. For instance, magnetite is easily separated from the material surrounding it by its effects on the magnetic needle; iron ore, by reason of its density, can be detected owing to its effects upon the force of gravity in its neighbourhood; while chalcopyrite deposits, by reason of their low electrical resistance, sensibly distort an electric field. For the best results a choice of the method most adapted to the circumstances must be made.

### THE MAGNETIC METHOD.

When the magnetic method of geophysical surveying is used the anomalies existing in the magnetic field of the earth in any place are investigated. It is

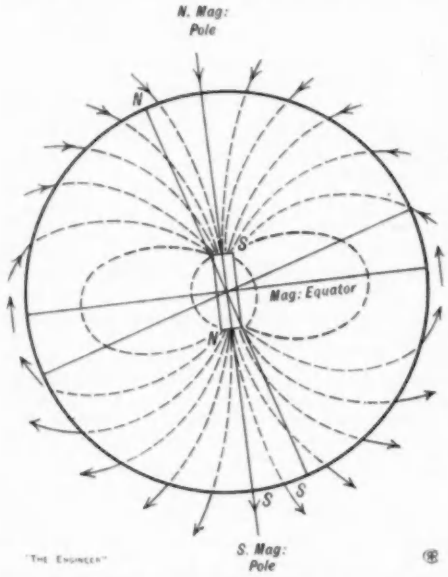



FIG. 2—DISTRIBUTION OF THE EARTH'S MAGNETIC FIELD

well known that the earth acts as a great permanent magnet, the poles of which are some distance from the geographical poles. In consequence, the magnetic meridian is not in line with the geographical meridian, the angle between the two being called the variation, while, owing to the shape of the earth, there is also a dip of one of the poles of a suspended magnet towards the ground. How this comes about is shown in Fig. 2, where the circle represents the earth. From measurements of the earth's magnetic field it is found that it can be represented very nearly by the field of a very short magnet, placed at the centre of the earth, which has its south pole pointing to the north magnetic pole of the earth. The lines of force produced by such a short magnet are shown dotted in the figure. A magnetic needle placed in the earth's field and freely suspended will lie along these lines. It can be seen at once that over the magnetic poles the magnet dips at 90 deg., while at the magnetic equator, which, of course, does not exactly coincide with the geographical equator, the magnet has no dip. If part of the crust of the earth is magnetic or permeable to magnetism, it will distort the lines of force in its neighbourhood and thus cause changes in the intensity, the dip and possibly the variation. For this reason the first instruments constructed for geophysical surveying measured the dip, the variation, and the intensity at each survey station, and the anomalies caused by highly magnetic materials in the sub-surface could be detected by these means. In more modern instruments, however, use is made only of the horizontal and vertical components, and in the majority there is no attempt to measure the absolute intensity of the field, but only the relative strength. Instruments constructed in this manner are exceedingly sensitive to small variations, and are known as "variometers." Such is their sensitivity that the operator in the field must carry or wear nothing with magnetic properties, and usually, before setting out for the day's survey work he performs gymnastic exercises around the instrument,

FIG. 3—VERTICAL FORCE VARIOMETER—WATTS

observing at the same time whether there is any deflection of the needle.

Nearly a century ago a vertical force variometer working on the principles which are still in use to day was invented by the Rev. Humphrey Lloyd. A

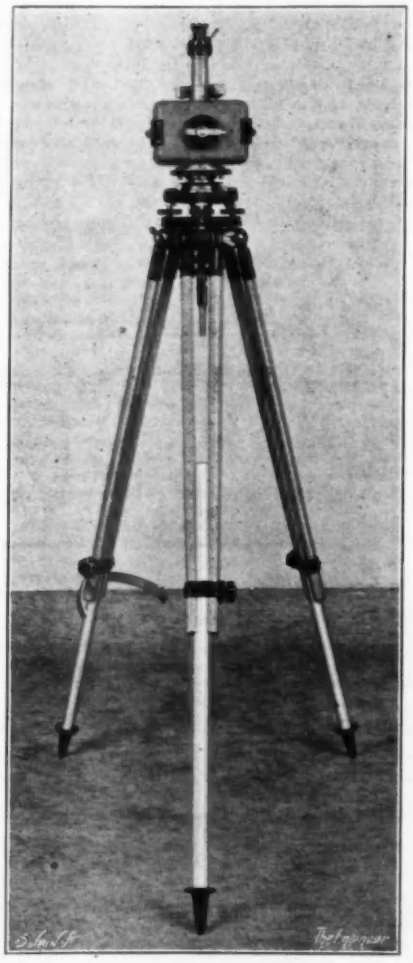


FIG. 4—VERTICAL FORCE VARIOMETER—WATTS

magnet was supported in such a way that its axis lay in a horizontal plane and perpendicular to the magnetic meridian. By placing the magnet in this position the effect of the horizontal component of the earth's field was eliminated and only the vertical component tended to tilt it. This tendency was balanced by adjusting a small counterpoise weight, the position of which gave the reading. In later instruments refinements have been added to the details of the design, but the principles remain the same.

Figs. 3 and 4 are reproductions of photographs of a typical modern design. It is the Watts vertical force variometer. In this instrument the magnetic system consists of two flat horizontally supported magnets made of cobalt steel, which are constructed for E. R. Watts and Son, Ltd., by the Cambridge Instrument Company, mounted parallel to one another upon a central aluminium block. They are provided with quartz knife-edges, which rest upon two quartz bearings. The system may be raised and lowered by means of a small table beneath, the operation being performed by rotating an external knob which is arranged to give rapid lowering at first and a more gradual motion as the knife-edges approach the bearings. Damping is provided by heavy copper dampers, and the whole sensitive part of the instrument is enclosed in a double-walled box, the interstices of which are filled with cork. This precaution minimises the effects of temperature changes. An auto-collimating telescope is fitted at the top of the instrument through which observations can be made. A mirror is fitted at the side, reflecting light into the instrument. Operation of the focussing screw does not affect its position, as the telescope is not rotated. To illuminate the interior a hole is provided on one side of the instrument, and a mirror is arranged in such a way that it can rotate around the hole, so that the best angle for reflection of the light within can be found without disturbing any other adjustments. The scales to be seen within the opening are those of two thermometers. The readings

FIG. 5—HORIZONTAL FORCE VARIOMETER—ASKANIA-WERKE

obtained from the magnet system must be corrected for temperature.

The apparatus is made in three parts. The instrument itself has already been described. Below it there is the centre-work, which during a survey is left in position on the third part, the tripod, but which is removed and packed separately for transport. This arrangement is followed with the intention of making the instrument more robust, and less susceptible to injury during transport.

When setting up the instrument the centre-work is first fixed on the tripod and levelled. A 3in. compass is then placed upon it, with an excentric pin registering with a hole provided and the centre-work rotated and oriented into the magnetic meridian. The compass is removed and the variometer, which is also provided with a registering device, is clamped down in its place. By the use of sensitive levels the instrument can then be finally and accurately levelled. The magnetic needles are set by these operations in the east-west position desired. Below the centre of the tripod there is a fitting provided with a scale, which will receive standard auxiliary magnets by the use of which the telescope scale may be brought back into view under strongly magnetic conditions. This can be seen between the legs of the tripod in Fig. 3.

In Fig. 5 there is reproduced a photograph of a horizontal variometer produced by Askania-Werke A.G., of Berlin-Friedenau. The firm makes a variety of geophysical instruments. Essentially, the horizontal balance is similar to the vertical, except that the magnets are suspended in the vertical position. The other fittings, such as thermometers, telescope, and auxiliary magnets, are placed in positions suitable to the changed suspension of the magnets. In the figure the instrument is shown with the calibrating coil fitted round it.

Before any use can be made of the variometer in

the field many things must be considered. It is well known, for instance, that the magnetic poles are continually wandering, and their position at the time that the survey is made may have to be ascertained. In addition, it is not so well known that there is a diurnal variation of magnetic intensity. At Kew, for instance, the range of variation of the vertical component is 30 $\gamma$ in summer and 13 $\gamma$ in winter, while the same figures for the horizontal component are 35 $\gamma$ and 15 $\gamma$ respectively. Although $\gamma$ is a very small unit, equal to 0·00001 gauss, the sensitivity of variometers, most of which can measure to 5 $\gamma$, is such that the diurnal variation must be taken into account if results are to be reliable. It is usual in the field, where possible, to obtain from an observatory

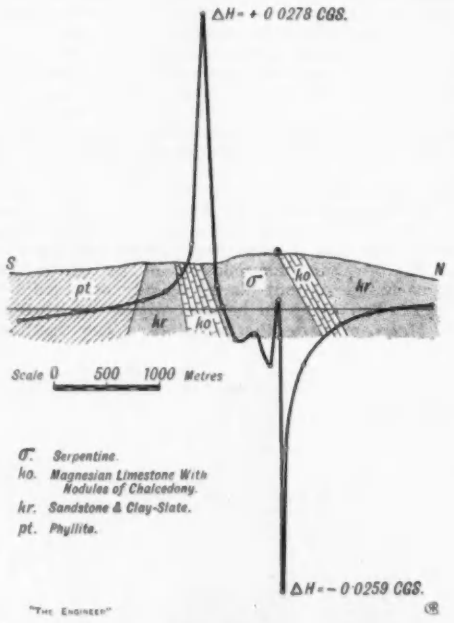



FIG. 6—MAGNETIC TRAVERSE OVER SERPENTINE

nearby the figures for this variation, but if no such observatory exists determinations must be made before the survey can be begun, and should be continued during the course of operations. Of less importance is the occurrence of electric storms, the effect of which is strong enough to vitiate any readings taken at the time.

In geophysical surveying by the magnetic method the aim is to discover and plot anomalies in the magnetic field of the earth. Such anomalies will be large and easily discoverable in the neighbourhood of strongly magnetic deposits, such as magnetite, while iron, nickel, and cobalt are all capable of causing a measurable disturbance of the earth's field. In Fig. 6 the sort of result that is obtained from a traverse over a magnetic material can be seen. Over one edge of the Serpentine there is a very well defined maximum in the disturbance of the vertical component of the earth's field, while at the other there is an equally pronounced minimum.

An instrument such as the Watts variometer can be used in all places where a magnetic deposit is to be discovered, while where non-magnetic materials are known to be associated with intrusions or flows of igneous rocks or other magnetic materials, the latter will provide sufficient indications. In addition, it can be used for the location of very insusceptible strata, and use has been made of the method for discovering salt domes on the flanks or top of which the uplifted oil-bearing strata occur. Faults, anticlines, and intrusions can also be found if one of the formations is magnetic. Since this method is relatively less costly than any other, it is usual to make a general survey of the kind over a wide area, other methods being used afterwards at the points which the magnetic survey has indicated as promising. In such a case contour maps of equal magnetic intensity are drawn. It will be obvious that an expert can read off from such a map the position of magnetic materials beneath the surface, while in favourable circumstances calculations can be made of the depth at which such deposits lie.

Very frequently, however, the magnetic method of survey can be used without the help of any other. Such a position is shown in Figs. 7 and 8, which give the results of a survey over Swynnerton Dyke, N. Staffs. We reproduce this survey from the Summary of Progress of the Geological Survey of Great Britain, 1929, by permission of the Controller H.M. Stationery Office. The dyke itself is a nearly vertical wall of igneous rock intruded in the Keuper Marls. Since it is magnetic, while the surrounding marls are not, it was particularly suitable for the magnetic survey which was carried out in 1929 by A. F. Hallimond. There are outcrops of the dyke in several places indicated on the map in black, and it was desired to trace its southward extension. The dotted lines show the position the extension occupies as found by the survey with a vertical magnetic balance. The traverses across the dyke are lettered A, B, C, &c., and the forces found at the points on each traverse are shown in Fig. 8. It will be seen that where the dyke is crossed there is a well-marked maximum, and that, according to the indications, the dyke has split in its extension into two or three branches. Calculations made from the results demonstrate that the surface of the dyke lies at a depth only a few feet below ground, while it is up to 5ft. in width.

Topographical features which have a great effect upon the gravitational method affect the magnetic not at all, while results are obtained more rapidly. No highly trained specialists are required to operate the instruments used. In consequence, this method is particularly applicable to general use, while, when conditions are favourable, it is useful for obtaining additional information, or for checking the results of surveys by other methods. On account of the speed with which surveys can be carried out, it is preferable to most other methods if a wide area is to be searched; but it must always be borne in mind that it is only capable of distinguishing between the magnetic properties of the materials in the sub-surface. For this reason magnetic surveys are usually followed up by surveys by other methods. As a rule, the vertical component is made use of for magnetic surveys, as, in general, the vertical intensity rises to a maximum immediately above the magnetic body, giving an easily recognisable indication of its position. In some places, however, it is advantageous to make use of the horizontal component. At the Equator, for instance, where the vertical component is very small, the anomalies in the horizontal component will give the more reliable results. Where this component is used the maximum value of the anomaly is found to form a band around the disturbing material, outlining it, in fact, upon the map.

Although primarily designed for use for discovering rocks and deposits of appreciably high magnetic susceptibility, instruments have been successfully used for detecting weakly diamagnetic salts. But in such circumstances the effects of quite small, but abundant, rocks, with different properties, may be sufficient to influence the position to such an extent as to conceal the slight anomalies for which a search is being made. Lastly, it must be remembered that though no specialists are required to work the instruments, experts must be employed to translate the results of a survey into geological language. Few such men exist at present, but the establishment of a chair of Geophysics at the Imperial College, South Kensington, is likely to cause the provision of an adequate supply in the near future.

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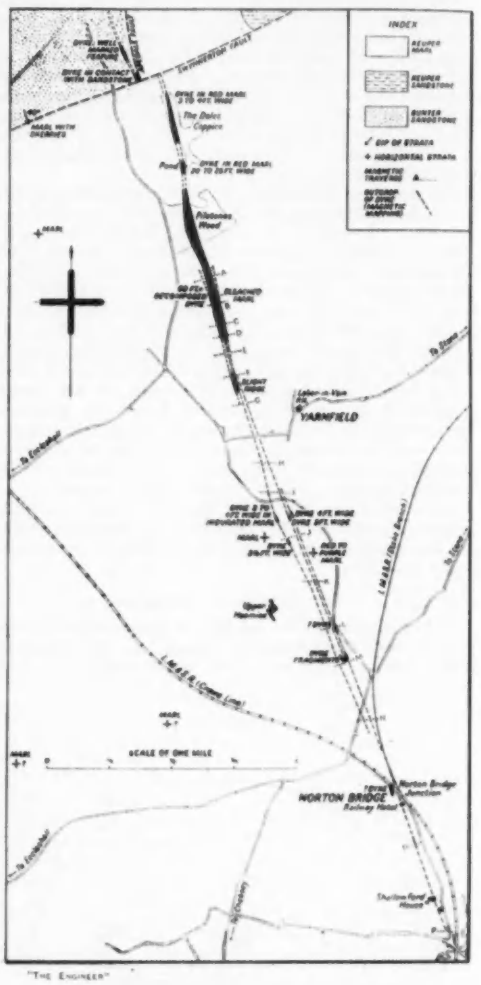


FIG. 7—MAGNETIC SURVEY OVER SWYNNERTON DYKE

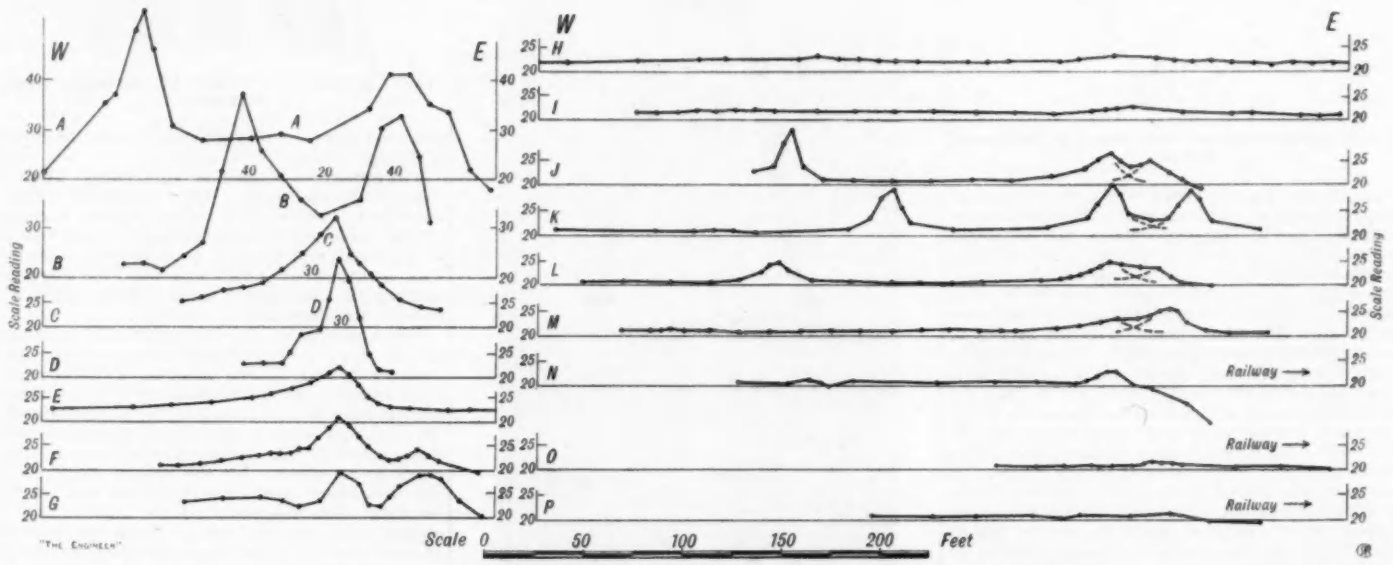


FIG. 8—MAGNETIC PROFILES FOUND IN TRAVERSES OVER SWYNNERTON DYKE

DURING 1930 the Belgian Air Lines (S.A.B.E.N.A.), operating with twenty-five, three-engined "Fokker" machines, which were in continuous service, carried 9445 passengers and 520,964 lb. of merchandise, while the weight of the mails carried was 49,094 lb. of letters and 36,311 lb. of postal parcels. The total distance covered by the machines was 711,196 miles, while they arrived at their destinations with a time-table regularity of 98·1 per cent.

# The Behaviour of Steel at High Temperatures.[1]

WHEN engineers began seriously to investigate the strength of steels at high temperatures, it soon became apparent that the standard methods of testing would need considerable modification because the earliest work showed that the results of tensile tests on heated specimens were largely dependent on the rate at which such tests were carried out, and that these results gave little information as to the load that could safely be applied for long periods without failure ultimately taking place. The fact that failure could and did take place if the load was maintained for a sufficiently long period, at stresses much below those determined by the ordinary short-time tensile tests, necessitated the introduction of a new method of testing in which the behaviour of specimens loaded for long periods at definite elevated temperatures could be observed.

Such tests, now universally known as "creep tests," are, for obvious reasons, both difficult and expensive to carry out, because they entail the use of elaborate and delicate apparatus by means of which the temperature can be kept constant within very narrow limits and by which the minute extensions of the specimens can be accurately measured. The introduction of the time factor also tends to place such tests beyond the scope of the routine testing house; weeks and even months having to be spent on a single test in order that accurate results may be obtained. Thus it is not surprising to find that a number of workers have attempted to devise a cheaper and quicker test which will give data sufficiently accurate to replace these expensive and lengthy "creep tests." The "time-yield" test of Dr. Hatfield explained later is a case in point. Other attempts to use the limit of proportionality or a certain "proof stress" as determined by short-time tests have been suggested with the object of avoiding the length of time occupied in making creep tests. As soon as the importance of these creep tests was realised a large number of investigators got to work, both in this country and abroad, and in what follows an attempt is made to compare and correlate their work. In doing this considerable difficulty is experienced due to the various angles from which the problem has been tackled and the various ways in which the results have been obtained and presented. In certain cases the procedure has been to determine what is known as the "limiting creep stress," *i.e.*, a stress, for any given temperature, below which, apart from a small initial extension, there is no creep but above which continuous creep leading to ultimate failure does take place. The existence of a "limiting creep stress" below which continuous creep does not occur is not, however, universally recognised, and some authorities maintain that creep will occur at all stresses above the limit of proportionality. The measurement of these extremely small rates of creep will be dependent on the delicacy of the extensometers, and such workers naturally prefer to express their results in terms of the stresses which produce the smallest measurable rates of creep—*e.g.*, $10^{-6}$in. per inch per hour—rather than attempt to estimate a stress producing zero creep. Other workers again state their results by giving the stress required to produce a certain small and arbitrarily fixed extension in a long and again arbitrarily fixed period of time—*e.g.*, 1 per cent. in 10,000 or 100,000 hours. The correlation of results is again not assisted by the different units adopted by various workers for the expression of their results.

As previously stated, those workers who seek to determine the limiting creep stress definitely ignore the small initial creep which occurs when the load is first applied, and they simply seek to determine a stress below which continuous creep does not occur. Other workers who express their results either as a rate or as the stress necessary to produce a certain extension in a fixed period of time do not always make it clear whether or not the initial creep is taken into consideration. Apart from these differences, many obvious discrepancies appear when the results of various workers are plotted on the same graph. Curves plotted on a temperature base are very steep and slight differences in temperature make large differences in the results. Consequently there is need for the most careful and accurate control of the temperature of the specimens, while the extensions which take place are so minute that they necessitate the use of extensometers of extreme delicacy. When it is realised that a variation of 20 deg. Cent. may correspond to a change of 20 per cent. in the limiting creep stress, the variations that appear between the results of different workers can readily be understood.

The methods employed in the determination of these limiting creep stresses are by no means standardised, but an outline of those employed by Tapsell and Clenshaw at the National Physical Laboratory, may be given as an illustration of the principle underlying such tests. In the first place, a definite load is arbitrarily chosen at which to make a series of tests at varying temperatures. The test bars are similar to an ordinary tensile test piece, and in the testing machine, usually of a lever type, the test bars are surrounded by a small electric furnace carefully controlled to within very narrow limits of temperature. Thermo-couple pyrometers are attached to the test bars and under the constant and chosen load each bar in turn is tested at a different temperature. In the majority of cases there is, first of all, a period of fairly rapid creep, which, if the temperature is well above that of the limiting creep value for the chosen stress, is maintained until failure takes place. If the temperature of testing is lower the initial rate of creep is not maintained, but is followed by a period of steady and slower extension. This rate, generally taken as the minimum rate of creep, is followed, if the temperature is high enough, by a period of more rapid creep leading ultimately to failure. When the temperature is only just above the limiting creep value the period of initial creep is followed by a long and usually undetermined period during which an exceedingly slow rate of creep takes place. From the results of such tests a minimum rate of creep for each temperature at the chosen load is obtained, and from this data it is a comparatively simple matter to obtain by extrapolation the temperature for the chosen load at which the rate of creep is zero or at least negligible. The tests are then continued with a different stress, and in this way the temperature for zero creep for each load is obtained, enabling a curve to be drawn showing the limiting creep stress for the steel in question at any temperature within the range investigated. Similarly, curves may be added showing the stresses and temperatures which correspond to various minimum rates of creep.

Published results of such tests show little or no relationship between the limiting creep stresses and the mechanical properties as determined by short-time tensile tests. Generally speaking, the limiting creep stress is much below the ultimate stress, but is above the limit of proportionality. The relationship, if it may be so called, between the limiting creep stress and the limit of proportionality has received a fair amount of attention. At temperatures below about 500 deg. Cent.—for ordinary carbon steels—the limiting creep stress lies above the limit of proportionality as determined by short-time tensile tests, as is to be expected. Several workers have shown that in such cases the limit of proportionality can be raised by stressing the steel to a point above the initial limit of proportionality, and they suggest that this is due to strain hardening and that this strain hardening must naturally occur during the creep test when the limiting creep stress is above the limit of proportionality. This may account for the fact that the creep curve shows a short early period of fairly rapid creep followed by a long period wherein the rate of creep is very much less. The designer here, then, has two values to which he can work, namely, the limiting creep stress and the limit of proportionality. If the former is used it must be remembered that there will be a certain initial and permanent deformation before the metal becomes rigid and creep ceases. If such deformation is not permissible, then the designer will have to work to the latter value and keep the stresses below the limit of proportionality.

At temperatures above about 500 deg. Cent.—for ordinary carbon steels—the strain-hardening effect is not so evident; the initial period of rapid creep observed at temperatures below 500 deg. Cent. is barely evident, and the minimum rate of creep appears to occur immediately at the commencement of the test. In this case any stress which gives rise to initial creep will ultimately cause failure. The curve obtained differs from the one previously described where a large initial creep is followed by a period of less creep. It is, however, possible that an initial period of more rapid creep does exist; but, if so, it is extremely small and would need exceptionally delicate instruments to detect it. In this case the designer has only one value on which to base his work, because it appears that the limiting creep stress lies below the limit of proportionality, as determined by short-time tests. This at first sight seems difficult to conceive, but it is probably due to the fact that in the short-time test there is insufficient time for appreciable creep to take place until a stress considerably above the limiting creep stress has been reached. The value for the limit of proportionality is therefore dependent on the rate of loading of the test piece in a short-time test. At temperatures above the "strain-hardening range," it is doubtful whether the rate of creep can actually be zero, whatever may be the case at lower temperatures.

The use of the limit of proportionality as a guide to safe working stresses at high temperatures has received much attention in view of the comparative ease and speed with which this value may be determined as compared with lengthy creep tests. From the foregoing, however, it appears to afford little guidance, for at temperatures where the metal undergoes this strain-hardening it is generally well below the limiting creep stress, and at higher temperatures the value for the limit of proportionality varies with the rate of loading and is of little significance. Another drawback to the use of short-time tests is that accurate information cannot be obtained in the case of steels which scale or oxidise or are subjected to changes of structure when exposed to high temperatures for long periods.

In order to investigate the relationship, if any, which exists between the limit of proportionality and the safe working load, Dr. A. E. White[2] carried out tensile tests at various temperatures on both solid and tubular specimens, as well as creep tests carried out in rather a novel manner. Thin seamless steel tubes filled with nitrogen at a pressure adjusted to give definite tensile stresses were heated at various temperatures and the diameters measured at intervals. For a 0·13 per cent. carbon steel and for a 0·38 per cent. carbon steel the safe working stress determined in this manner was found to lie below the limit of proportionality as determined by the short-time test, while in a 16·5 per cent. chromium-iron alloy a closer approximation of the two existed. In brief, while the experiments did not appear to show any definite connection between the two values, the limit of proportionality appeared to give a reasonably close approximation and to be the best short-time test available.

The use of the yield point is not very successful, in so far as the yield point proper ceases to exist when temperatures of about 200–300 deg. Cent. are reached and any work on these lines necessitates the introduction of an arbitrarily fixed "proof stress"—that is, a stress which would produce some small arbitrarily fixed extension.

The use of values given by short-time tensile tests is therefore very limited and the lengthy creep tests are at present the only ones that can be relied upon to give accurate data upon which safe working stresses can be based. In order to expedite these tests resort has been made to multiple testing machines, in which perhaps four test bars in one furnace and, of course, at one temperature are differently loaded. As already stated, the variations in the procedure adopted by different workers and the various ways in which the results have been expressed make correlation of the work difficult and in this survey certain liberties have necessarily been taken with a view to bringing the results of the different workers into line.

Amongst the pioneer work on the subject of creep tests reference must be made to J. H. S. Dickinson,[3] whose paper "The Flow of Steels at a Red Heat," in 1922, pointed out the effect of creep in reducing the strength of steel at high temperatures. The work of Professor Lea[4], published in 1924, was, it is believed, the first comprehensive survey of the subject and the methods of plotting creep curves and extrapolating in order to determine the limiting creep stress, or "temperature-viscosity stress," as Professor Lea termed it, were introduced in this paper.

In order to compare the work of Tapsell and Clenshaw and of Batson and Tapsell with other workers, it is necessary to disregard the estimated limiting creep stresses and consider the stresses which produce various minimum rates of creep, and which in their work are stated in terms of stresses producing extensions of 0·001in., 0·0001in. and 0·00001in. per inch per day and which for the sake of comparison must be converted into inches per inch per hour. It will be sufficiently near for our purpose if we take these extensions as 0·00004in., 0·000004in., and 0·0000004in. per inch per hour respectively.

In a recent paper by K. Baumann[5] entitled "Some Considerations Affecting Future Developments of the Steam Cycle," it is pointed out that "recent experiments have shown that material may creep for long periods at a rate of $10^{-8}$ (0·00000001in.) per inch per hour at stresses which are considerably below what have previously been assigned to the creep limit." The curves given in this paper, when compared with those of Batson and Tapsell, appear to be somewhat lower, although the general trend is the same in both cases. Some differences here are due to the fact that the two workers are experimenting with steels of slightly different carbon content, but this in itself is not sufficient to account for the variation. The superiority of the Ni-Cr-Mo steel, the analysis of which is unfortunately not given, is also well marked, particularly at temperatures up to about 1000 deg. Fah. (540 deg. Cent.). In considering these results it should be remembered that the curves are obtained by taking the minimum rate of strain for each given condition of stress and temperature, ignoring the initial strain, which is of much greater magnitude than that which follows and on which the minimum rate is based.

It will be of interest to compare the results which have been obtained on ordinary carbon steel with those obtained on some of the new steels.

In America a considerable amount of work has been carried out on behalf of the Babcock and Wilcox Company by F. H. Norton, the results of whose researches are now published in book form.[6] In this investigation, apart from ordinary plain carbon steels and ordinary alloy steels, a number of stainless and austenitic steels have been examined. Although the results obtained here are strictly comparable one with another, comparison with other workers' results is made difficult by the fact that the experiments have, in the main, been carried out at higher temperatures than those previously considered. Nevertheless, the results of Norton can be compared with those of Batson and Tapsell over the range of temperature 550–650 deg. Cent. and, as far as the ordinary carbon steels are concerned, there is a fairly close agreement, the stresses for creep rates of $10^{-6}$in. per inch per hour being approximately 2 tons per square inch at the lower temperature and about ¾ ton per square inch at the higher, according to Norton, and 3¼ tons per square inch at the lower temperature and 1 ton at the higher, according to Batson and Tapsell. The results given by Baumann are somewhat lower. It should, however, be remembered that this comparison ignores the variation in carbon content of the various steels; Norton's carbon steel containing 0·45 per cent. C, as against a 0·17 per cent. C steel of Batson and Tapsell and a 0·15 per cent. C steel of Baumann.

An examination of Norton's results reveals at once the fact that there are three distinct groups. The lowest group, *i.e.*, the one with the lowest resistance to creep, includes the carbon steels and the ordinary alloy steels which at temperatures of 1000 deg. Fah. or upwards show little or no superiority over the plain carbon steels. The second group, having a somewhat higher resistance to creep, is composed of the high-chromium type of stainless steels, but most noticeable is the great superiority of the third group, generally known as austenitic steels, high both in nickel and chromium.

Norton points out, however, that the selection of a steel for use at high temperatures does not depend on its creep resistance only; the question of cost must also be considered. The alloy steels of his first group cost perhaps twice as much as the carbon steels, but their creep resistance is little, if any, better. The stainless steels with creep resistances of two to three times as much as the carbon steels cost from ten to fifteen times as much. The austenitic steels—high chromium and nickel—have a creep resistance at high temperatures about ten times that of the carbon steels and they cost little or no more than the stainless steels. Therefore, according to our present knowledge the most economical steels to use are either carbon steel, where the range of temperature is not too high, say, up to 750 deg. Fah., and above that temperature austenitic steels; in fact, when other factors such as resistance to scaling are considered, the latter are the only practical material. Even so the old question as to whether the increased economy due to the use of high temperatures is going to exceed the increased interest and depreciation charges on the more expensive material should be asked and answered in each specific proposition.

Reference has already been made to the fact that the length of time necessary for the carrying out of creep tests greatly restricts their value for commercial purposes and that many attempts have been made to substitute shorter tests which will give data of sufficient accuracy. Thus Dr. Hatfield,[7] pointing out that the limiting creep stress is a value well within the zone of stress which produces definite plastic deformation, suggests that what the designer really wishes to know is the stress which can be safely imposed without change of dimensions within the time in which he is interested. The method of Dr. Hatfield, which he calls the "time-yield," consists in discovering, by static loading, the stress within which, at the given temperature, stability of dimensions is attained within a period of twenty-four hours for a further period of forty-eight hours, with an extension not exceeding the elastic deformation of 0·5 per cent. on the gauge length, and with limitation as regards measurement for permanence of dimensions of the order of one millionth of an inch per inch per hour. In this method the time of testing is reduced, therefore, to a period of three days.

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[1] From the report of the Engineer-in-Chief, Mr. V. B. Harley Mason, to the Executive Committee of the Manchester Steam Users' Association.

[2] THE METALLURGIST, January, 1928.

[3] "The Flow of Steels at a Red Heat," J. H. S. Dickinson, J.I.S.I., 1922.

[4] "The Effect of Low and High Temperatures on Materials," F. C. Lea, I. Mech. Eng., Dec., 1924.

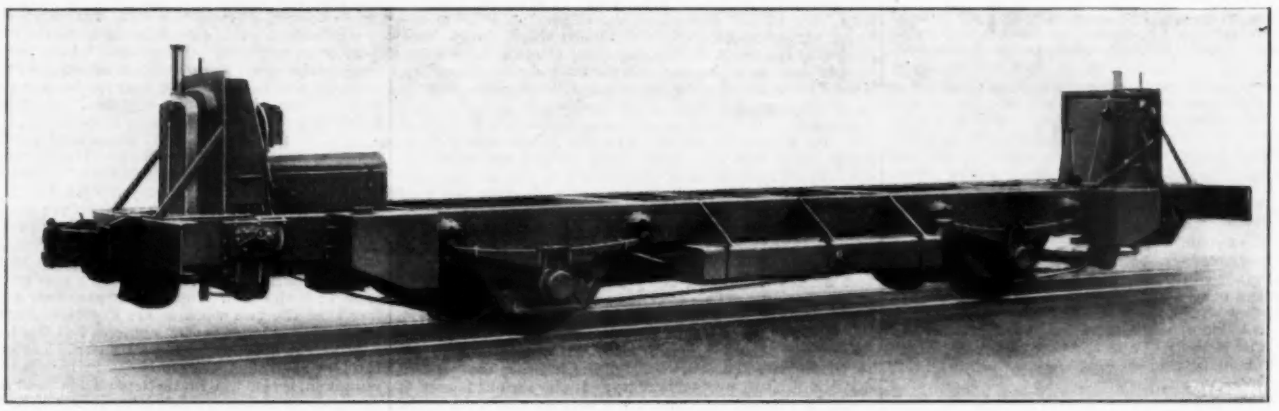
[5] I. Mech. Eng., Nov., 1930.

[6] "The Creep of Steel at High Temperatures," F. H. Norton.

[7] "The Permanence of Dimensions Under Stress at Elevated Temperatures," Dr. W. H. Hatfield, I. & S.I., Sept., 1930; THE ENGINEER, Oct. 10th, 1930, p. 408.

# ARGENTINE TRANSANDINE RAILWAY—CHASSIS OF PASSENGER COACH

HARDY MOTORS, LTD., SLOUGH, ENGINEERS



A series of short-time tensile tests carried out on a mild steel when compared with the time-yield values for the same steel shows that at 300 deg. Cent. the latter are only slightly below the proof stress—in this case based on an extension of 0·1 per cent.—but the time-yield curve increasingly diverges downwards from the proof stress curve, cutting across that of the limit of proportionality at a temperature a little in excess of 450 deg. Cent. The effect of time is thus well brought out. When it is considered that in determining the limiting creep stress the period of initial extension may be of several days' duration, it is understandable that the time-yield figures which only permit of one day's initial extension will be lower in value than the limiting creep stresses determined in the usual manner, and the time-yield curve is accordingly lower for this steel than the corresponding limiting creep stress curve, although the two curves tend to converge when a temperature of 500 deg. Cent. is attained.

Short-time tensile tests at 15 deg. Cent. and time-yield tests at temperatures between 200 deg. Cent. and 700 deg. Cent. have been made by Dr. Hatfield on a number of carbon and alloy steels. The chief points to be noted from these results are that, as far as the mild steels and ordinary alloy steels are concerned, the time-yield values drop rapidly with temperature, and at 550 deg. Cent. there is no figure as high as 3 tons per square inch. As far as the rust, acid and heat-resisting steels are concerned, the most noticeable feature is the serious drop in the time-yield value of the silicon-chromium and chromium stainless steels between 400 deg. Cent. and 500 deg. Cent. The figures obtained from the austenitic nickel-chromium steel are very interesting and bear out to some extent the results of F. H. Norton previously mentioned. In the case of this austenitic steel the fall in the time-yield with increase in temperature is relatively gradual and is not subject to the drop between 400 deg. Cent. and 500 deg. Cent. experienced by the preceding steels. However, of this group the most outstanding steel is the nickel-chromium-tungsten steel, which maintains comparatively high values up to 700 deg. Cent.

In the third group no outstanding results were obtained and at 600 deg. Cent. they all fall to 3 tons per square inch or less.

The results obtained give a fair idea of the properties of steel at high temperatures and also show the superiority of certain classes of steel for high-temperature work, but until these tests are standardised and a uniform system of expressing results is adopted the full value of the data obtained cannot be appreciated by the designer in whose mind the further question of a factor of safety also arises; but here again there is as yet no standardisation. Dr. Hatfield, referring to his time-yield, suggests that a stress of two-thirds the time-yield can be regarded as a safe working stress. Dr. Jacobus[8] suggests that the value of a safe stress may be taken as one-fifth the ultimate tensile strength as indicated by short-time tensile tests or as two-thirds the creep limit, whichever is the less.

In all cases the adoption of what may be taken as a safe stress depends largely on circumstances, and it is difficult to formulate definite standards, particularly when there are such variations in the data available.

The impression may have been formed that the rates of creep which have been discussed are too small to be considered in connection with steam plant, but it is necessary to realise that a creep rate of $10^{-7}$in. per inch per hour will result in an increase of dimensions of 1 per cent. in ten years and a rate of $10^{-6}$ an increase of 10 per cent. in the same time. Rates of creep of this order occurring in a bolt holding a joint against steam pressure would result in leakage in a very short time. A creep rate of $10^{-6}$in. per inch per hour occurring in a steam turbine casing 4ft. in diameter would increase the diameter by nearly 1in. in a period of two years.

According to Baumann, the permissible rates of creep for various portions of steam plant are as follows:—

I.—Turbine discs pressed on shafts, $10^{-9}$in. per inch per hour.

II.—Bolted flanges, turbine cylinders, $10^{-8}$in. per inch per hour.

III.—Steam piping, welded joints, boiler tubes, $10^{-7}$in. per inch per hour.

IV.—Superheater tubes, $10^{-6}$in., $10^{-5}$in. per inch per hour.

Regarding the effect of creep on tubes and shells, reference must be made to the work of R. W. Bailey, whose paper, "Thick-walled Tubes and Cylinders Under High Pressure and Temperatures," deals largely with the mathematical side of the subject. An earlier paper by R. W. Bailey[9] dealt fully with the necessity of the measurement of creep rates of the order of $10^{-8}$ and described his experiments on the creep of steel under both simple and compound stresses.

Before leaving the subject of the strength of steels at high temperatures and in particular whilst dealing with steam pipe flange bolts a phenomenon known as "temper brittleness" may be mentioned. Temper brittleness is a weakness which is only detectable by means of a notch impact test such as the Izod, and is not evident from the results of a tensile test. Temper brittleness has long been known to occur in nickel-chrome steels which are tempered, after hardening, in a range of temperature from about 250 deg. Cent. to 400 deg. Cent., or even cooled slowly through this range after tempering at a higher temperature, and it is for this reason that such steels are oil quenched after tempering.

In many cases bolts in steam pipe flanges are of nickel-chrome steel and are subjected to temperatures conducive to the production of brittleness. We have come across cases in which nickel-chrome steel bolts, having an original Izod value of about 70 foot-pounds, have, after a year or so in service, been found to have values as low as 5–10 foot-pounds. No change in tensile strength or ductility has been observed to accompany this embrittlement, which is only observed by means of the impact test.

The introduction of molybdenum into such nickel-chrome steels has been supposed to have an inhibiting effect on this temper brittleness, but much more research will be necessary before any definite conclusions can be reached. As to what this embrittlement actually is we have no knowledge. It appears to be unaccompanied by any visible changes of microstructure, and if such changes are occurring we can only assume that they must be submicroscopic in character.

Such a phenomenon need not be considered unique, as is shown by the somewhat similar case of the intergranular weakness which occurs in austenitic steels when heated for even short periods to between 500 deg. and 900 deg. Cent. and which is probably due to the separation of carbide round the crystal grains. Claims have been made that the addition of a small percentage of tungsten will prevent the steel being subject to such intergranular weakness, probably by increasing the stability of the carbide in the solid solution, but one prefers to withhold judgment until more definite evidence is available and more experience has been gained.

In selecting a steel for flange bolts, while it is necessary to consider its qualities from the brittleness standpoint, yet on account of the heavy stresses thrown on the bolts when tightening up and during warming-up periods, its resistance to creep must not on that account be overlooked.

[8] "Working Stresses of Boiler Steels at High Temperatures," D. S. Jacobus, A.S.M.E., Dec., 1929; THE METALLURGIST, 1930.

[9] R. W. Bailey, "The Creep of Steel Under Simple and Compound Stresses," World Power Conference, Tokio, 1929; THE ENGINEER, Vol. CXLVIII., 1929, p. 528.

## Rail Coach for the Argentine.

THE chassis of a rail coach for the Argentine Transandine Railway, which has been built by Hardy Motors, Ltd., of Slough, and was demonstrated at the works yesterday, is illustrated by the half-tone engraving above.

It is, it will be seen, of the four-wheel type, and is intended to carry a body seating about thirty-two passengers. The overall length of the chassis is 32ft., and the wheels are spaced at 14ft. 6in. centres. The engine is a 110 horse-power six-cylinder unit, made by the Associated Equipment Company, Ltd., of Southall, similar to that described in connection with a single-deck motor coach in our issue of May 1st last. It has cylinders 110 mm. in bore by 130 mm. stroke, and is fitted with a Solex carburetter, an A.C. air cleaner, and forced lubrication to all the main and big-end bearings. There are seven main bearings for the crank shaft, all 2¾in. in diameter. The fan is positively-driven by the timing chains, and the circulation of the cooling water is also positive, being effected by a centrifugal pump. There are two radiators, one at either end of the chassis, which are connected in series by 2in. piping. There is also an auxiliary tank of 45 gallons capacity, to which the water may be by-passed if desired by means of a three-way cock. Air scoops are fitted beneath the frame to carry air up to the radiators and cowls arranged in the rear.

The clutch is of the single plate type, 16in. in diameter, and provides a total bearing surface of 380 square inches. The clutch case and gear-box are connected directly with the engine, to make one unit. The gears give four ratios of 4·37 to 1, 2·69 to 1, 1·59 to 1, and 1 to 1. All the wheels have ground teeth and the shafts also are ground. Beyond the change speed gear-box there is a reversing gear, which comprises two trains, one of two wheels and the other of three, all 3½in. wide. They are all mounted on ball or roller bearings, and are in constant mesh, the changes being effected by means of dog clutches. The drive is transmitted to both the main axles by means of double-reduction gearing, carried in cast steel casings mounted on the axles on large roller bearings. That is to say, there is a pair of spiral bevels, which drives a countershaft, and this shaft drives the axle through double helical gears. The ratio of these gears is 5·3 to 1, so that the overall ratios from the engine to the wheels, which are 2ft. 6in. in diameter, are 23·2 to 1, 14·3 to 1, 8·4 to 1, and 5·3 to 1. As the engine will run comfortably at anything from 1000 to 2500 revolutions per minute, the travelling speeds can be computed from those ratios.

There are brakes on all four wheels, which are operated by a 6in. by 8in. Westinghouse brake cylinder, and, alternatively, by a screw-down hand wheel. Air for the brakes is supplied by a compressor directly driven by the engine, and two 12in. by 47in. air reservoirs are provided. Sand-boxes are arranged for all four wheels, and are worked by Westinghouse air valves.

The controls are duplicated at each end of the chassis, and, in the case of the change speed gear are interconnected by means of a light gauge tube fitted with universal joints. The changes are effected by the rotation of this shaft, to select the gear, and then moving it endways, so that a change box is necessary at both ends of the vehicle. The other controls comprise a clutch pedal, a reverse lever, the screw-down hand brake, an accelerator pedal, and the throttle and ignition levers. On the hand brake column there are also mounted the air brake valve, the sanding valve, and the whistle.

The main frame is of steel throughout, and the side numbers are 12in. deep by 3½in. wide. The cross numbers are channel shaped with closed box ends, and the couplers are of the Henricot type. The springs are 5ft. long by 3½in. wide. The petrol tank, which can be seen on the side of the main framing, has a capacity of 45 gallons.

## B.E.S.A. SPECIFICATIONS.

*All B.E.S.A. Specifications can be obtained from the Publications Department of the Association at 28, Victoria-street, London, S.W. 1. The price of each specification is 2s. 2d. post free, unless otherwise stated.*

### VARNISHED CLOTH FOR ELECTRICAL PURPOSES.

The British Standard Specification No. 419, 1931, which has just been issued, relates to yellow and black varnished cotton cloth, as used for the insulation of electrical machinery and apparatus. Two types of varnished cloth are included, these types being designated yellow varnished cloth and black varnished cloth respectively. The yellow and black varnished cloth can frequently be used for the same purpose, but, apart from the question of appearance, which may be of importance in determining which colour is adopted for a particular purpose, there are certain well-defined differences between the yellow and black materials, and these differences are clearly set out in the specification. Yellow varnished cloth is manufactured with a drying oil base, and black varnished cloth is coated with a varnish in which bitumen or similar material is one of the ingredients, and is responsible for the black colour. The varnished surface of the black cloth is softer and less resistant to crushing or abrasion than that of the yellow. The latter will stand immersion in hot oil better than black varnished cloth, and may, therefore, be said to have a higher resistance to oil. Black varnished cloth will, in general, withstand chemical fumes in the atmosphere better than the yellow. The black material is also rather more water repellant, and has slightly higher electric strength.

After pointing out the above differences between the yellow and black material, the specification deals with the dimensions and tolerances thereon, the requirements as regards joins, rolling and packing, electric strength, tensile strength, tearing strength and ageing. The methods of test are fully described in a number of appendices.

The specification is based on information supplied by the British Electrical and Allied Industries Research Association, and the limits given have been adopted after considerable investigation of existing varnished cloths, strips and tapes.

## The Inverted Condenser.

THE fact that a modern steam turbine can utilise efficiently the energy which is rendered available by the expansion of steam down to the lowest absolute pressures commercially obtainable, has rendered the design of condensing plant a matter of the greatest importance. The first steam turbine ever to be provided with a condenser was a machine of 100-kW capacity, built by Messrs. C. A. Parsons and Co. in 1891 for the Cambridge Electric Light Company, and from this time onwards Messrs. Parsons have always devoted the closest attention to the improvement of condensers and their auxiliaries. Many notable inventions in this field stand to the credit of the firm, amongst which must be mentioned the "vacuum-augmentor," from which nearly all modern types of air extraction apparatus are more or less directly descended.

The latest development which Messrs. Parsons have made in the art of condenser design is particularly interesting on account of its somewhat revolutionary nature. They have produced a new type of condenser in which the usual arrangements are completely inverted, the steam flowing upwards instead of downwards through the tube banks, and the air being drawn off from the highest point of the shell. The inversion of the steam flow involves a corresponding inversion of the water flow in order that the coldest tubes may be at the top of the condenser instead of at the bottom. The new design has been arrived at as the logical result of the study of all the factors which experience and theory have shown to be essential to the best performance, without regard to conventions based merely on traditional practice. It permits of a very high coefficient of heat transmission with the minimum expenditure of power, it ensures the condensate being drawn off at the highest possible temperature consistent with the vacuum, and it provides for cooling and extracting the air under the best conditions. There are other advantages of a practical nature which will be evident from an examination of the design.

Condensers of the "inverted" type are built in two forms, according to whether single or double turbine exhausts have to be accommodated. The principles are the same in each, and will be readily understood by reference to the section of a single-exhaust condenser illustrated in Fig. 1. The steam enters by the central branch at the top and is guided directly to the bottom of the condenser by baffles running the whole length of the body between the tube plates. Only then can it enter the tube system, through which it flows upwards on each side till condensation is complete. The water of condensation formed on the tubes falls downwards, and since the coldest tubes are at the top, the water is never cooled by coming into contact with a tube colder than itself, as is almost inevitably the case with ordinary condensers in which the coldest tubes are at the bottom. Furthermore, during its descent the condensate is falling through the rising steam current, and finally has to pass through the fresh incoming steam before reaching the outlet to the extraction pump. As a consequence, the condensate is delivered at the full exhaust steam temperature, and being extracted as far away as possible from any part of the shell where air might accumulate, it can carry away practically no gases in solution. The spacing of the tubes and the cross-sectional area of flow are diminished progressively from the bottom to the top of the condenser, so as to maintain an approximately constant steam velocity. The whole of the tubes do their part in air cooling, and the position of the air outlets at the top of the shell avoids any necessity for baffles to screen the tubes in the neighbourhood of the air pump suctions from falling drops of water. Indeed, there are no baffles of any kind among the tubes, so that the flow of both steam and air are unrestrained. The importance of causing the incoming steam to enter the tube system over a large area has been fully recognised, while the inversion of the steam flow affords an absolute protection of the tubes from the impingement of the water drops flung off from the last row of the turbine blades at a very high velocity. Thus the danger of tube leakage which may occur in an ordinary condenser as a result of the erosion of the upper tubes is completely eliminated.

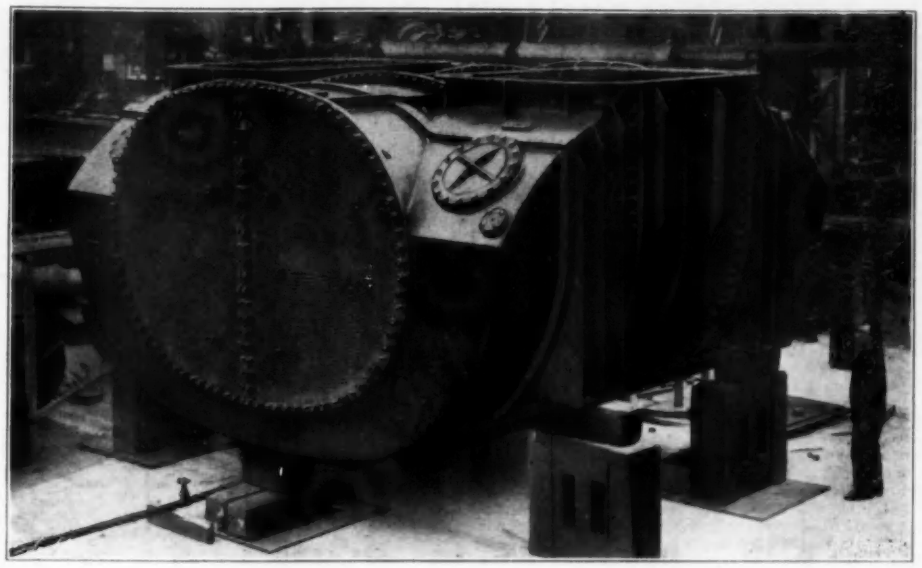


FIG. 3—TWO-FLOW INVERTED CONDENSER

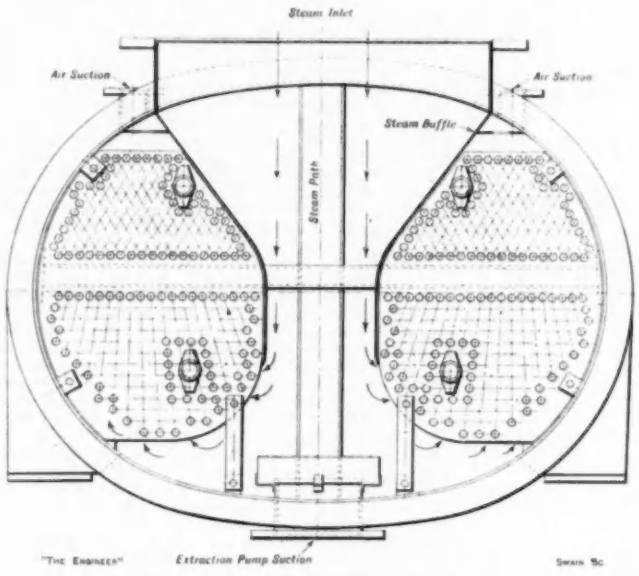



FIG. 1—SINGLE-EXHAUST INVERTED CONDENSER

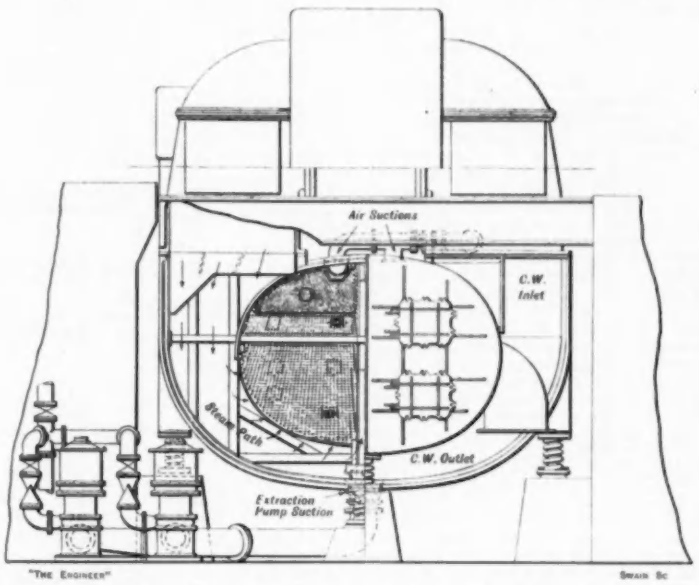



FIG. 4—DOUBLE-EXHAUST INVERTED CONDENSER

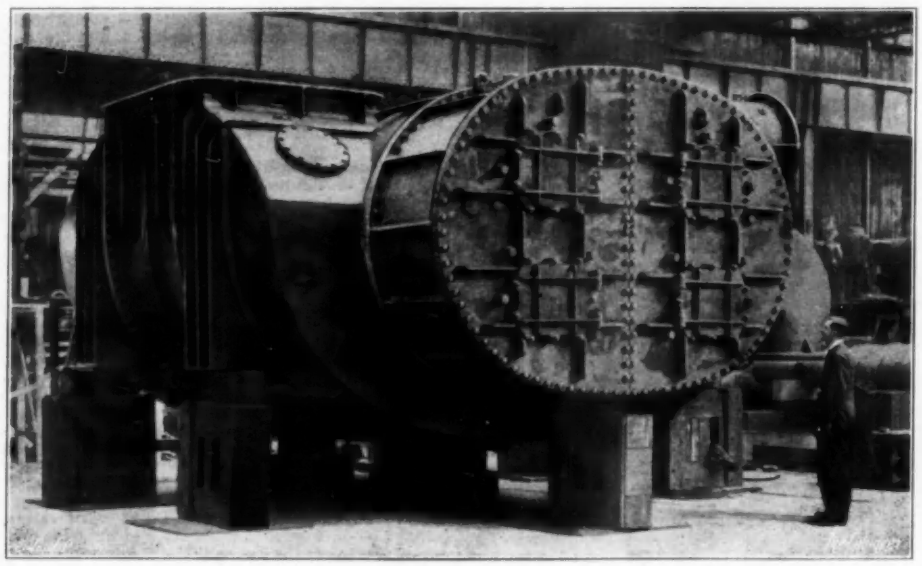


FIG. 2—TWO-FLOW INVERTED CONDENSER

When the inverted condenser is designed for a turbine cylinder having a double exhaust, the arrangement is as shown in Fig. 4. In this case the steam passes down to the bottom of the condenser on each side of the tube system, before entering the lower tube bank. Its flow through the tubes is upwards towards the air suction branches, exactly as in the previous case, and the same advantages are obtained. The design lends itself, as will be seen, particularly well to use with double-flow low-pressure turbine cylinders, for the exhaust branches are conveniently situated and a single condenser placed at right angles to the turbine may be adopted.

The external appearance of an inverted condenser recently constructed by Messrs. C. A. Parsons and Co. at their Heaton Works, Newcastle-on-Tyne, is illustrated in Figs. 2 and 3. It is of the two-flow type, 16ft. long between tube plates, with a cooling surface of 20,000 square feet. It will maintain a vacuum of 29in. with cooling water at 55 deg. Fah. when condensing 164,000 lb. of steam per hour. In accordance with Messrs. Parsons' practice, the merits of the inverted design were confirmed by exhaustive tests before the new type of condenser was put on the market. The firm's standard type, is still supplied for conditions where the advantages of the inverted condenser would be neutralised by some special difficulty in installing it.

## The Silent Valley Reservoir.*

THE Silent Valley Reservoir, when constructed, will complete the Mourne Mountains Scheme for which powers were obtained by the Belfast City and District Water Commissioners in 1893, the first work to be carried out being the aqueduct to convey water from the Mourne Mountains to Belfast, which was brought into use in 1901. This aqueduct, about 35 miles in length, conveys the supply of water derived not only from the area of approximately 5500 acres, draining to the site of the embankment of the intended reservoir on the Kilkeel River, but also from that of about 3400 acres on the adjacent Annalong River, and delivers it into the Knockbracken Service Reservoir.

The average rainfall on both drainage areas amounts to about 60in., and provision was made to store 3000 million gallons of water in the Silent Valley by means of an embankment having a length of 1500ft. at top water level, and a maximum height of 88ft. above stream bed level, this storage being sufficient to ensure a supply of about 12¼ million gallons per diem from the Silent Valley Drainage Area alone. The Act of 1893 provided for a second reservoir situated in the Annalong Valley, but as the amount of storage, which will be provided by the Silent Valley Reservoir is so large, it would appear to be unnecessary, as by diverting the Annalong River through a tunnel 2 miles in length into this reservoir, the maintainable supply could be increased to about 17¼ million gallons per diem. The continued increase in demand for water emphasised the necessity of constructing the Silent Valley Reservoir, and a contract was therefore let to Messrs. S. Pearson and Son in 1923 under the direction of the late Mr. McCullough, M. Inst. C.E., the Water Engineer to the Commissioners, and a past-President of the Institution of Water Engineers, who was responsible for the original design, but, unfortunately, died at an early stage of the work.

The lower part of the Kilkeel Valley is filled by glacial deposits, consisting of silt, silty sand, and boulders, and the embrankment was located so as to rest on an ancient moraine which was cut through by the river. Bore-holes which had been sunk prior to the letting of the contract indicated that granite rock would be found at a depth of about 50ft. below the surface in the valley bottom.

The first permanent work to be undertaken was the driving of a tunnel through solid granite on the east side of the valley, as until the river was diverted through this tunnel it was not advisable to open up the trench in the valley bottom. The river having been diverted, the cut-off trench was commenced at the beginning of 1926, when it was discovered that as the excavation advanced towards the valley bottom, the surface of the rock dipped downwards more rapidly than should have been the case if the information obtained from the bore-holes was correct. It was therefore decided to sink six further bore-holes, the positions of which are shown on the section appended hereto, the last of which was completed by the end of the year and showed that the rock instead of lying at a depth of about 50ft. was actually about 200ft. below the surface at the deepest part of the valley. These bore-holes were sunk with considerable difficulty, as numerous boulders, some of great size, were encountered, and it appeared therefore probable that the original bore-holes, which were thought to have reached the rock, must actually have terminated in large granite boulders.

Meanwhile, an endeavour was made to sink a timbered shaft for the purpose of dewatering the strata, but this work had to be abandoned as the material penetrated became of such a nature as to run freely with water, entering the shaft as rapidly as it was excavated. An attempt was then made to drive down a circular ring of interlocking steel piles so as to form a sump from which the water could be pumped, but this method had also to be abandoned, as the piles could not be driven through the boulders.

It became apparent that the work of sinking the trench to so great a depth through material of such a character presented difficulties of a very grave nature, and that the methods envisaged in the original contract were impracticable. An Agreement was therefore entered into in December, 1926, under which the contract was altered to a cost-plus-percentage basis during an exploratory period, the work to be carried out under the direction of a Board of Engineers, consisting of Mr. H. P. Hill, Mr. Edward Sandeman, and Mr. W. J. E. Binnie. The exploratory period was to continue for twelve months, at the expiration of which period the Board were to advise the Commissioners whether they considered it to be possible to construct a reservoir on this site.

The construction of the embankment and ancillary works presented no special difficulties, but it was impossible to impound water by means of this embankment unless the percolation of water through the permeable material underlying the bank could be prevented, and in order to effect this object it would be necessary to carry the cut-off wall right down to the rock through running sand and boulders. A very large expenditure amounting to about £400,000 had already been incurred on works which would be rendered useless if the reservoir could not be constructed on this site. If the silt and silty sand which ran freely when saturated with water could be induced to part with some of its moisture, the material would become sufficiently stable to be excavated without difficulty.

The only method which promised success was to construct drainage shafts under conpressed air, as the pressure of the air would drive the moisture out of the silt and silty sand and prevent the run of material into the shaft. It is not either advisable or practicable to subject men working under compressed air to a greater pressure than 30 lb. to 35 lb. per square inch above the atmosphere, and as the water level in the material stood at a comparatively short distance below the surface prior to the commencement of operations, it was evident that the pressure of air necessary to exclude the water would become too great long before the shafts reached the rock at the centre of the valley. This difficulty could, however, be overcome if it was found that the level of saturation in the strata could be lowered by pumping, and the following procedure was adopted:—

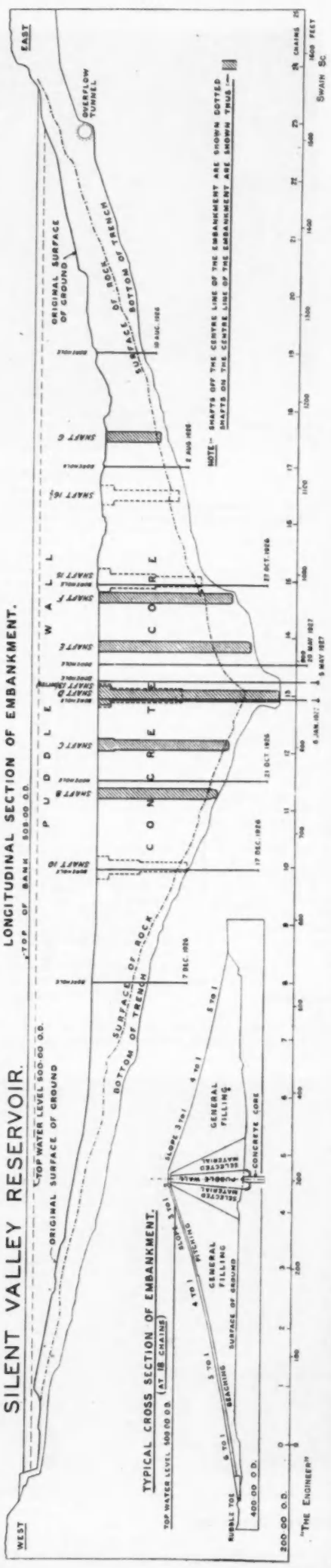
When the first shaft had reached the depth limited by the air pressure, the work of sinking was to cease. A strainer was to be placed in the bottom to minimise the entry of sand, and pumps were to be installed by means of which water could be withdrawn from the surrounding strata. An adjacent shaft was to be started somewhat later, which would reach a lower level before the air pressure became too great if the pumping at the first shaft proved to be effective in lowering the water level in the strata. When the greatest attainable depth had been reached by this second shaft, the pumps were to be transferred to it, and it would then become the pumping shaft. Work under compressed air was then to be recommenced in the first shaft while the pumping from the second shaft continued to lower the water level in the strata, the sinking of the first shaft being again suspended when the maximum air pressure had been reached, and so on.

By adopting this procedure it was hoped that the water level in the strata would gradually be lowered sufficiently to permit of the rock being reached. As this method proved successful, four shafts were sunk lined with cast iron and spaced at intervals adjacent to the centre line of the embankment, the positions of these shafts being shown on the section appended hereto. Two additional bore-holes were also put down to endeavour to locate the lowest level of the surface of the rock in the pre-glacial valley, as it was desirable that one of the shafts should be sunk at this point to ensure the drainage of the glacial material right down to the bottom. Work proceeded on the lines indicated above during the year 1927, and by the end of the year the Board were able to inform the Commissioners that they were of opinion that it would be possible to construct the reservoir on this site. This estimate was made before the final drawings had been prepared, and it is satisfactory to be able to say that it will prove to be approximately accurate.

It was recommended that instructions should be issued authorising the excavation of the trench, and in June, 1928, a scheme was put forward to sink six further shafts, 11ft. to 12ft. in diameter and spaced about 56ft. apart, which are lettered B–G on the section. These shafts are situated on the centre line of the cut-off trench, and were to act first as drainage shafts to dewater the trench, and were afterwards to be filled with concrete to form part of the "cut-off" wall, a portion of the cast iron lining being removed so that the concrete was continuous throughout the length of the trench. It was further decided to line the trench, where over 100ft. in depth, with cast iron segmental plates held apart by timber struts, and connected to the shafts at each end, the struts to be removed as the concrete was brought up. The silt exercised so great a pressure that it would have been impracticable to line with timber in the ordinary way, as insufficient space would have been left for raising and lowering the skips. The cast iron plates were also of great advantage in other ways, as they avoided spaces through which sand could run and facilitated the injection of grout into the material behind the plates, which was found to have a considerable effect in reducing the rate at which running sand entered the trench, and also filled any cavities which were formed behind the plates.

Instructions were received to proceed with this work, which was accordingly commenced in June, 1928, and the last of the shafts, which was 211ft. in depth, was completed by June, 1929, having penetrated about 30ft. into the rock, the surface of which was soft and decomposed. It was found that the bore-holes had predicted the position of the bed of the pre-glacial stream with accuracy, as this shaft was sunk at the exact spot. Meanwhile, work on the trench proceeded rapidly till the water level was reached, below which considerable difficulty was experienced owing to the running sand. The excavation for the trench, except for a short length where the river crossed it, was completed by the end of October, 1929, and a good rock foundation secured right across the valley. It is a curious fact that the quantity of water pumped from the strata remained nearly constant at about one million gallons per diem throughout the whole period of construction. Difficulties constantly presented themselves during the period of construction, but were overcome as they arose, thanks to the skill of the contractors and the unremitting care which was exercised by them.

The filling of the trench with concrete and the works of construction which followed are of so ordinary a character that they call for little comment, especially as they are visible above ground, whereas the work which we have described will never again be seen. The works for the disposal of flood water by means of a bell-mouth weir and tunnel are now approaching completion, and are of some interest.




* Paper presented to the British Waterworks Association at its annual meeting, July 22nd, 1931, by the Board of Engineers. Abstract.

## LOBITO BAY RAILWAY.

AN event of supreme importance to South Central Africa, which will in the near future have repercussions of a momentous nature upon transportation problems in Africa south of the Equator, took place on July 1st and was officially celebrated. It was the linking up of the railway from Lobito Bay, in Portuguese Angola, to the main system running through Belgian Congo, and it was officially celebrated at the point where it passes from one territory into the other. There was a large attendance from various parts of Africa, and the visitors from overseas included Sir Robert Williams, to whose inspiration and efforts the completion of the railway is mainly due. The new line, from its junction with the main Congo system to the sea, is 1180 miles in length. The rails met on March 10th and passenger services are already in operation. July 1st was chosen for the formal opening, as it was the anniversary of the founding of the Congo Free State, now the Belgian Congo. A traveller can now go entirely by rail across Africa from the Atlantic to the Indian Ocean, and the rich Katanga Province is in direct communication with ports to the west, to the east and to the south. To put it perhaps more clearly, the ceremony of July 1st was the formal opening of the Leokadi line, Leopoldville-Katanga-Dilolo Railway, connecting the inland terminus of the Benguela Railway from Lobito Bay with the main trunk Congo Railway system from Sakania to Port Francqui. This latter system connects Cape Town and all South African ports and also the towns in Southern and Northern Rhodesia with the navigable waters of the basin of the Lower Congo and through Leopoldville with the Belgian port of Matadi at the mouth of the Congo River.

## Railway and Road Matters.

AT a meeting of railway stockholders on July 22nd, it was decided to form a Railway Reform Association. This was the result of an appeal in *The Times* by Sir Charles Stuart-Williams for communications from those who, like himself, thought reforms were necessary.

ANSWERING a question addressed to him on July 15th, the Minister of Transport stated that the railway companies had informed him that steel was now used in the construction of a modern railway coach to the extent of about 75 per cent. of its total weight, and that the number of such coaches constructed during the last twelve months, in substitution for vehicles mainly made of wood, was 1401.

A QUESTION of the twenty-four-hour system of indicating time may be regarded as dead. It was stated in the House of Lords that the Government Departments concerned had re-examined the question, and found that there was no evidence of a general or widespread desire for the change. On the railways there were very few journeys of sufficient duration to make the use of a twenty-four-hour time-table a real necessity.

THE Great Western claims the fastest night service in the British Isles. It is given by the 1.40 a.m. express from Paddington to Plymouth and Penzance, which covers the 225¾ miles to Plymouth (North-road) in 265 minutes, or an average speed of 51·2 miles per hour. This actually is not a new train, but the conveyance of passengers by a train which hitherto has carried newspapers only, for which, we believe, the newspapers pay a subsidy.

THE locomotives on the Southern Railway, at least those on the central and eastern sections, are to be renumbered. Hitherto, the numbering has been the same as in pre-grouping days, but those on the L. and S.W. section have had the prefix E—for Eastleigh—those on the Brighton lines have had B—for Brighton—and the former South-Eastern and Chatham have had the prefix A—for Ashford. The prefix has now been abandoned from the first-named, the S.E. and C. section engines have had 1000 added, *e.g.*, A 260 is now A 1260, and the Brighton locomotives have 2000 added, and B 384 becomes 2384.

WHEN dealing with the Weir report, in his reply to the debate on the Vote for the Ministry of Transport, Mr. Morrison said that the "railway companies have communicated to the Government, not their detailed views upon that report, but a letter which indicates certain broad considerations. The question has been raised as to the publication of that letter. I am not terribly afraid of the publication of the letter, but I thought it right that the question of publication should not be determined until I had had an opportunity of communicating with the railway companies and had given them an opportunity of elaborating their point of view. I have now arranged to meet them on Friday of next week [to-day] when the whole problem will be discussed between myself and the railway companies."

IN the debate in the House of Commons on July 23rd, a Labour Member referred to the Act of 1844, and said that it gave the State power at any time, on certain conditions, to purchase any railway made or authorised since 1843. That is a very widely prevailing impression, but the facts are not as related. What the Gladstone Act of 1844 did was to lay down the terms of purchase, but, to quote Sec. 4, "whereas it is expedient that the policy of . . . purchase should in no manner be prejudged by the provisions of this Act but should remain for the future consideration of the Legislature, . . . be it enacted that no such notice . . . shall be given until provision shall have been made by Parliament, by an Act or Acts to be passed in that behalf for authorising . . . the levy of the purchase money."

THE Metropolitan interim dividend is at the rate of 1 per cent. for the half year. The receipts were £28,000 down, but economies have reduced the amount to a decrease of £6000. A year ago the interim dividend was 1¼ per cent. The Southern Railway sustained a loss of £500,000 on the half year, of which £400,000 was in passenger traffic. Expenditure was, however, reduced by £300,000. The interim dividend on the preferred ordinary stock is 1½ per cent. for the half year, as against 2½ per cent. in 1930. The London and North-Eastern suffered a fall in revenue of over 3 millions, but economies were effected to the extent of 2 millions. Interim dividends are being paid on the 4 per cent. first and second guaranteed stock, on the 4 per cent. first preference stock, and the 5 per cent. redeemable preference stock. Payment for the two latter necessitates a transfer from the general reserve fund. It may be noted that passenger engine mileage was reduced by 3·68 per cent. and freight engine mileage by 8·59 per cent.

THE paragraph as to privately owned wagons in this column on July 17th had no reference to the question as to whether or not all wagons should be owned by the railway companies. The privately owned wagon has its rights. It was there before there was a railway—using the latter term in its general acceptance—and the earlier railway wagons, until the companies became carriers, were privately owned. Moreover, all the railway companies, except the North-Eastern and the Scottish, deliberately exempted themselves in their respective enabling Acts, from the necessity to provide wagons for certain traffic—in other words, that traders must send such traffic in privately owned wagons. Our paragraph, referred to in a letter by Mr. Roberts in our issue of July 24th, was inspired by the comparatively fewer number of failures of couplings in privately owned wagons to those in railway owned. It is true, as Mr. Roberts points out, that the journeys of the former are more numerous than those of the latter, but that feature is more than counterbalanced by the rough usage the 650,000 privately owned wagons have to contend with in their "three trips a month" in comparison with the "almost a loaded trip a day" of the 450,000 "ordinary wagons for general traffic purposes." Finally, we would say that this aspect of the wagon question is one to which we have devoted attention since the specifications for privately owned wagons were issued, as the result of a collision at Penistone on January 1st, 1885, when four lives were lost following the failure of a wagon on a passing train.

## Notes and Memoranda.

ACCORDING to the report of the Forestry Commissioners for last year, the total addition to the woodland area of Great Britain was increased by 14,155 acres and about sixty-three and a-half million trees were used. They were almost all conifers.

OUT of the total number of marine engineers examined by the Board of Trade under the Merchant Shipping Acts of 1863, who have numbered over 100,827, those who have secured "tickets" include 6951 members of the Institute of Marine Engineers.

IN his presidential address to the first International Conference on Public Cleansing, which has just been held in London, Mr. J. C. Dawes, of the Ministry of Health, said that public cleansing in England and Wales costs £11,000,000 a year. He urged that the business should be recognised as being definitely technical.

SOME remarks on the effect of tin salts on the corrosion of steel containers are made in the report of Sir W. B. Hardy, of the Department of Scientific and Industrial Research. He shows that two parts per million of tin were sufficient nearly to halve the rate of corrosion of iron, and that such a concentration of tin was quite innocuous to human beings.

THE eye, extraordinarily sensitive though it otherwise can be, experiences great difficulty in discriminating between white and nearly white substances. To this end, an instrument has been designed wherein the eye of the observer has been replaced by a photo-electric cell, which enables the instrument to measure accurately the extremely small differences between "white" surfaces. By this means differences inappreciable to the eye of even a trained observer can be detected.

IT appears that attention is again being given to the matter of the enormous loss by evaporation of the waters of the White Nile in the stretch between Lake No and Lake Albert. This district is a morass, and impedes the free flow of the head waters to the Nile. So an aerial survey has been organised over the country with the idea of deciding upon two alternatives—the cutting of a channel through the "sudd," a mass of vegetable refuse, and of making an alternative channel outside the sudd area. The Bahrel Zeraf, a sluggish stream to the east of the White Nile, has in the past been suggested as the route for such a change. Either scheme would involve vast expenditure, and might completely disturb the local conditions.

IN the Bulletin No. 220 issued by the University of Illinois Engineering Experiment Station there are described the tests of a "Mikado" type locomotive equipped with Nicholson thermic syphons, conducted in co-operation with the Illinois Central Railway Company and the Locomotive Fire-box Company. A syphon is a supplementary water leg or circulating chamber riveted to the roof of the fire-box and the bottom of the tube plate to stimulate the circulation of the boiler water and increase the transfer of heat. The results of the tests showed that the syphon-equipped locomotive possessed a definite and notable superiority over the non-syphon engine as regards both evaporation per pound of coal and boiler efficiency. Under identical conditions of operation, the weight of steam generated per pound of coal would be on the average 8·5 per cent. greater with the syphons than without them.

AN unusual case of pipe corrosion has recently been brought to the notice of the Copper and Brass Extended Uses Council. A large institution put in a service of both hot and cold water pipes in copper about 1910. Till quite recently the installation was satisfactory, but a little while ago the water supply was chlorinated and treated with alumina-ferric. Trouble began to occur in the horizontal lengths of the hot water pipes. The trouble was eventually traced to rust from the iron tanks, settling on the bottom of the horizontal pipes where the flow was slowest, and there, with the help of the treated water, setting up electrolytic corrosion with the copper. The trouble was found to be due to over-alumination of the water, which resulted in an increase of acidity. It has been recommended that the water should be treated with soda-ash in addition to alumina, or by substituting sodium aluminate in place of the alumina.

IN the annual report of the Northern Coke Research Committee, Mr. Briscoe states that: "Further work on the blending of coals has been carried out, using the experimental oven. Blends of Cumberland, Durham, Northumberland and Scottish coals have been prepared and it has been found that the quality of the coke, as judged by the Shatter test, may be improved by carefully regulated blending. In general, it has been found that small additions of an inferior coking coal to a good coking coal and that small additions of a good coking coal to an inferior coal, produce more than proportionate effects in the Shatter index of the coke. In this respect a 20 per cent. addition seems to be a critical quantity in both types of result. In many experiments an optimum blend composition has been discovered, such a blend sometimes giving a coke of higher Shatter index than that obtained from either of the parent coals."

IT was shown in Safety in Mines Research Board Paper 54, published in 1929, that the frictional heat from the impact of chain coal-cutter picks against certain rocks was capable of igniting fire-damp. Further experiments with both chain and bar coal-cutters and with different kinds of rock are described in another paper just published, "The Ignition of Firedamp by Heat of Impact of Coal-cutter Picks Against Rock," by M. J. Burgess and R. V. Wheeler. It has been found that ignition could be obtained with both types of coal-cutter when cutting against quartzitic sandstone or micaceous sandstone with quartzitic inclusions, which both yielded a localised form of sparking, appearing as red streaks or vivid reddish flashes at the points of contact between the picks and the rock. This type of sparking appeared to be essential for ignition. Fortunately, rocks of the kind with which ignition was obtained are not of frequent occurrence with the coal measures. When cutting against pyrites or ironstone, showers of bright yellow sparks were produced, but no ignition could be obtained. The paper can be obtained from H.M. Stationery Office, price 9d.

## Miscellanea.

THE last main girder of the new Bally bridge at Calcutta was put in place on July 27th.

A PLANT for the production of seamless steel tubes is being put up near Welland, Ontario.

IT has been decided to expend 5,500,000 dollars on the construction of two tunnels under the Nachine Canal at Montreal.

IT is intended to put up a factory for the manufacture of cellophane, the wrapping material, in Quebec, at a cost of about 1,500,000 dollars.

THE Cuyahoga River, passing through Cleveland City, U.S.A., is to be widened so that it will be navigable by ore ships 600ft. long, at a cost of 6,000,000 dollars.

IT is proposed to provide a supply of potable water for Moose Jaw, Regina, and some other towns of South Saskatchewan at a cost of about 16,000,000 dollars.

A FACTORY is being built near Montreal by Jenkins Brothers, Ltd., for the manufacture of valves. It includes an iron and a bronze foundry, and is to cost some 2,000,000 dollars.

IT has been decided to construct a bridge between Cross Point and Campbellton, across the Restigouche River in Quebec, at a cost of about 1,500,000 dollars. It will be about 4060ft. long.

IT is expected that the cantilever bridge over the Washington Canal at Seattle, Washington, will be completed by September. It is 3000ft. long, with an 800ft. main span, and was started towards the end of 1929.

IT is reported that the Kobe Steel Works wire rod plant is being extended, and the output raised from 50,000 tons a year to 150,000 tons. When the project is complete, it is said that there will be no need to import foreign rods into Japan.

A REFINERY is shortly to be established at Moose Jaw, Saskatchewan, with a daily capacity of 400 barrels of crude oil. About £25,000 are to be invested in the plant, which will produce petrol, paraffin, distillate, fuel oil, and other petroleum products.

THE new superphosphate fertiliser unit at Hamilton, Ontario, of the Groselti Chemical Company, which has just started work, has a capacity of 75,000 tons of 16 per cent. superphosphate a year. The raw materials will be drawn principally from Florida and Morocco.

THE Cochin harbour improvement, in India, has been completed, and there is now a depth of 37ft. throughout the channel, which is about 2 miles long and 450ft. wide. The dry dock is finished and work is being started on the reclamation of land on which to build a new town.

THERE has been erected on the water front at Victoria, British Columbia, a Sperry aviation beacon equipped with a 24in. Bausch and Lomb mirror, giving a beam of 10 million candle-power. It is fixed on the top of a 70ft. concrete tower and is said to be visible for about 70 miles.

THE first native-manufactured automobile was completed at the Min Sen factory, an auxiliary organ of the Shenyang Arsenal, in China, on June 19th. A special reception was held by the staff of the factory to celebrate China's first achievement in the manufacturing of motor vehicles.

ABOUT one-third of France's requirements of manganese ore, which amount to about 700,000 tons per annum, will, says *Chemistry and Industry*, in future be supplied by Morocco. The French steel manufacturers propose to construct a railway from Bou-Arfa to Oudjda for the transport of the ore.

IT is reported that the Hydromasch Syndicate intends to put up a large factory in Swerdlowsk, Russia, for the manufacture of chemical engineering plant. It is to have a foundry with an annual capacity of 30,000 tons, and will concentrate largely on the production of acid resisting cast iron.

A FACTORY for the production of titanium white is, says the *Chemical Trade Journal*, to be erected in the Urals, to work a process that has been developed by Professor Mecklenburg, of the Varnish and Colour Institute, of Moscow. The principal raw material is to be the slag produced in the smelting of titaniferous magnetite in the blast-furnace.

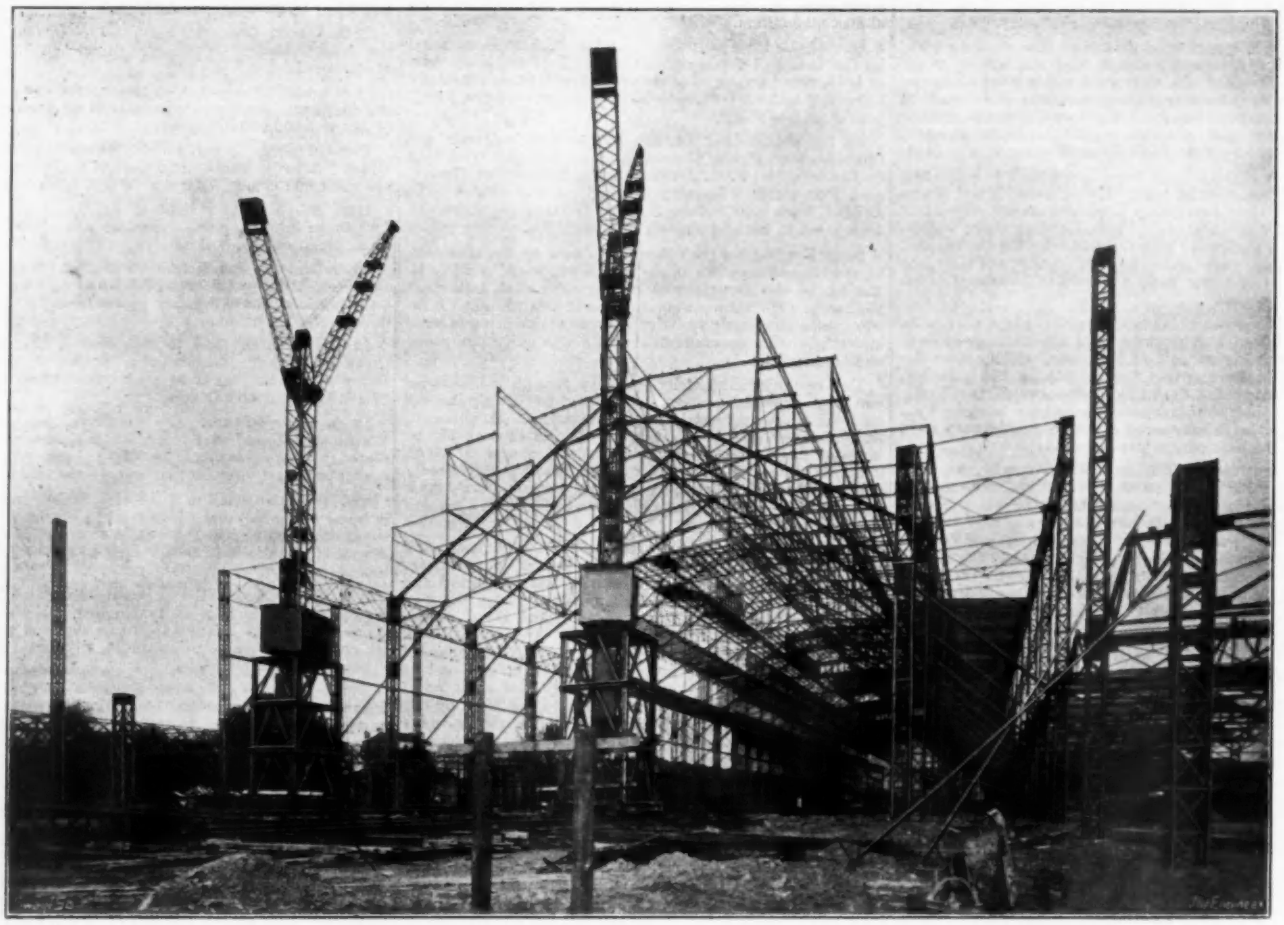
ACCORDING to *Canada*, Sir Alexander Gibb, who is making a survey of Canadian harbour facilities, is now—July 20th—conducting investigations at Saint John, New Brunswick, where the docks were destroyed by fire. The first efforts of the visiting engineering staff will be directed to the help of the stricken port. Reconstruction work on the destroyed Canadian Pacific termini has already been begun. Enough of the docks will be rebuilt before the winter to preserve the port's winter shipping. The Dominion Government will lend 10,000,000 dollars to the Harbour Commission for the rebuilding of the docks.

THE Bill of the Grand Union Canal Company, which has just passed a third reading in the House of Commons, gives sanction to the purchase of the Leicester and Loughborough navigations and the Erewash Canal, already approved by the shareholders. It will increase the length of the waterways under the company's control by 40 miles to a total length of 280 miles. The company will now be able to proceed with the improvement of seventeen locks between Watford and Foxton, which is to cost £150,000, in order to allow the passage from the Thames to the Trent of boats larger than those that have hitherto been used.

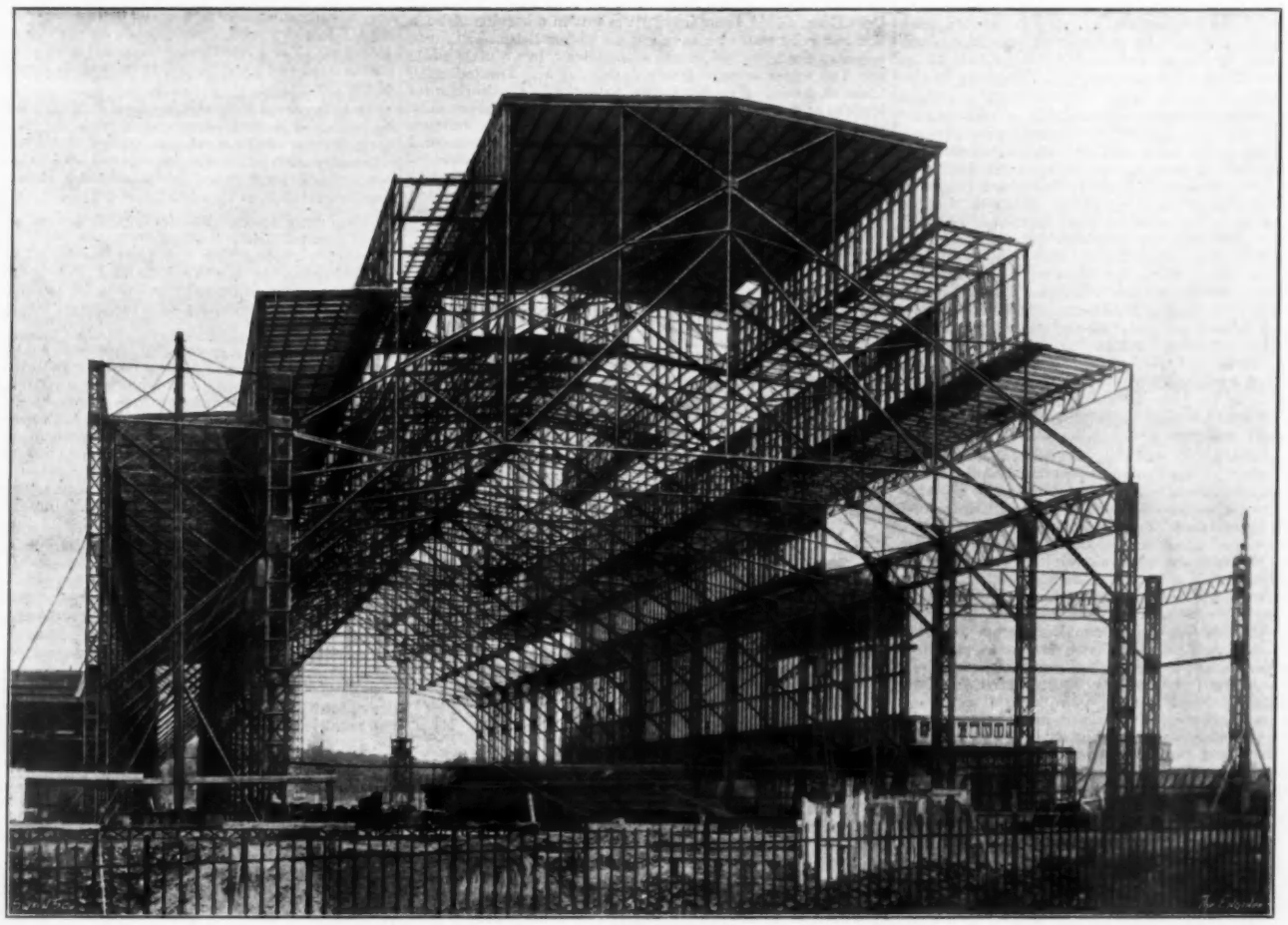
ACCORDING to the naval correspondent of the *Daily Telegraph*, the United States battleship "New Mexico," the first large vessel of any navy to be propelled by electricity, is to have her turbo-electric drive replaced by steam turbines. This remarkable decision has been taken on grounds of economy. While the electric plant is officially stated to have been highly successful, it appears to be costly in operation, and by the change a saving of £60,000 will be effected. Moreover, the horse-power will be increased from 32,000 to 40,000. Two sister ships, "Mississippi" and "Idaho," are also to be converted from electric to steam drive.

# PARIS COLONIAL EXHIBITION—SECTION MÉTROPOLITAINE BUILDING

(*For description see page* 127.)



BUILDING DURING CONSTRUCTION SHOWING ERECTION CRANES, LOOKING SOUTH



BUILDING NEARLY COMPLETED, SEEN FROM SOUTH END

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# THE ENGINEER.

VOL. CLII. No. 3942


## *JULY* 31, 1931.

### Geophysics.

THERE is a wonderful similarity in the history of the development of each of the sciences. In the majority of cases the seed from which each grew was planted so far back in the mists of prehistory that no man can say definitely that here began the study of that science or of this. Although the essential facts were hidden for century after century, acquaintance with properties, actions and reactions was slowly gathered. At first what poor knowledge was possessed was so distorted by rogues, charlatans and dreamers that sensible men put little faith in it. But gradually a class of men, true scientists, enthusiastic only for the discovery of truth and not troubled overmuch by the effect the revelation might have upon the beliefs of the day, came into being and the acquisition of knowledge proceeded at a greater rate until at last the time arrived when the principles gathered so laboriously could be applied to more catholic usage. As complete understanding of the principles involved became more general the science was accepted as one of the tools of mankind with all its mysticism stripped from it. Each science has much the same story to tell, but the time scale varies so that although many natural properties and phenomena were understood early, some are yet hailed as novel and are incompletely understood at the present day. In the latter class perhaps the comparatively new science of geophysics may be placed. Although its principles have been used successfully for many years, and are being applied each day to obtain greater and greater accuracy, yet to the general run of mankind the prediction of the position of deposits, the location of buried faults and anticlines, and all the other physical characteristics of the geology of the earth—many of them some thousands of feet below the surface—smacks still of quackery. Unfortunately, the science of geophysics has not yet passed far enough along the time scale to be entirely free from the effects of the mystic era, and the public is still inclined to regard the predictions, and even the successes, of those interested in it with that same doubtful gaze with which they have for ages watched the antics of diviners. This scepticism was fostered in the latter half of the seventeenth century by the users of an instrument invented by Daniel Tilas, called the Swedish mining compass. Owing to the imperfections of the instrument considerable experience was necessary if it was to be operated successfully, and the opportunity was taken to attach a certain amount of superstition to its use. At the present time a certain reticence in the statements of makers and users of instruments, particularly those for electrical geophysical surveying, can, we think, have but a similar result. The public will continue to classify such surveying with dowsing, which, whether or not any subtle truths lie beneath its apparent absurdity, has never been proved to rest upon any scientific basis. Yet geophysics is based upon sound and well-understood natural phenomena, and as such has no connection with the art of divining.

Geophysics might be defined as the science of discovering what lies beneath the surface of the ground by taking measurements above. A variety of natural properties can be used in these determinations. The magnet will obviously be affected by materials beneath the surface, and it was, in fact, the first instrument to be used for the purposes of geophysics. Deposits either highly magnetic or the reverse at once cause variations in the position of the needle, and these, properly interpreted, will give indications not only of the position, but also of the size and weight of the buried body. It is not, perhaps, quite so obvious that very heavy or very light bodies will cause variations in the strength of gravity in their neighbourhood, and that measurements of these anomalies will give, if not precise, at least sufficiently accurate information regarding the cause of the disturbance. The phenomena of earthquakes have directed the attention of scientists to yet another available property of the earth's crust—its elasticity—and the measurement of "controlled" earth shudders provides information of a kind sufficiently accurate to make such surveys part of the accepted practice of many companies. The Anglo-Persian Oil Company, for instance, uses the method for the discovery of oil at considerable depths. Finally, the knowledge that the materials forming the crust of the earth have differing resistances and susceptibilities to the passage of electric currents has opened the door to yet another field of operations. When the properties the geophysicist uses are considered, little wonder can be felt that the new science has lagged behind others on the time scale and has only recently emerged from the mystic era. In every case it will be found that great knowledge of another science had first to be gathered before that of geophysics could begin to be applied. The magnet, it is true, was known very early. Indeed, if somewhat legendary history is to be trusted, it was used by the Chinese while Europe was still a welter of barbarianism. But though the magnet was used the properties of magnetism were not discovered until centuries later. The forces and laws of gravitational attraction, though mistily detected previously, were not put upon a scientific footing until Newton explained the motion of the planets. Earthquakes, until a comparatively recent date, were regarded as undesirable visitations from whatever gods were worshipped at the time, and the door to any possible investigation was therefore closed before any rational thought could be devoted to the problem of their occurrence, while, excepting those of thunderstorms, also believed to be under the control of some deity, the phenomena of electricity were a closed book to the ancients.

It is, therefore, not surprising that a science so useful to mankind in this industrial age should have developed so slowly. Sufficient matter on which to begin experiments had only been gathered by the middle of last century. But since then progress has been rapid and, once given his start, the geophysicist can provide for the scientist and the instrument maker sufficient data and criticism to ensure that the rate of progress shall accelerate. The setting up of a chair in the subject at the Imperial College of Science and Technology at South Kensington, which is occupied by Professor Rankine, will also do much to bring about the same result. The advance that has already been made is, we think, unsuspected by the public. As an illustration it may be said that before 1924 forty salt domes—with which are connected oil-bearing strata—had been discovered in the Gulf Coast area of Texas and Louisiana in America. Since that

date and up to the middle of 1930 no less than 156 were found by geophysical methods. If any more proof is needed of the *bona fides* of the new science the exhibition of instruments and surveys at the Science Museum in South Kensington will provide it. As the visitor observes these instruments and realises the perfection of their construction, and that they are obviously made for work of the greatest accuracy, all suspicion that geophysics is even remotely connected with dowsing must be banished from his mind. Here, indeed, he is confronted with the instruments and the results of the application of a new science.

### Flue Gases in Furnaces.

Now that air-heaters are becoming general in connection with power station boilers, the effect of a possible leakage of flue gases into the entering air has sometimes formed a subject for discussion. Such leakage as is likely to occur in practice is hardly sufficient to make much difference one way or the other, but it opens up the whole question of the benefits, or otherwise, of deliberately diluting the combustion air with flue gases. This is no new idea. Forty years ago, or more, it was suggested and, indeed, put into practice in the operation of gas producers for metallurgical furnaces, and was revived a few years ago by Babcock and Wilcox, Ltd., in connection with steam boilers at the North Tees, and more recently at the Barking and Barton power stations. The theory is simple. Just as the steam in a producer is decomposed by the glowing carbon, with the formation of free hydrogen, so is the carbon-dioxide brought in with the flue gases reduced to the valuable monoxide. The process cannot, of course, be carried on continuously without the admission of some free oxygen to maintain the temperature required for the reaction. This, however, is no serious drawback, for the use of steam in producers is subject to the same limitations.

To reason from a gas producer to a boiler furnace one has to realise the points of difference as well as the similarities. Both make, as one of their primary products, carbon-monoxide gas, and the fact that this has afterwards to be utterly burnt in the furnace, whereas its combustion must be, as far as possible, avoided in the producer, is of minor importance. It is the question of temperature which controls the operation of the respective plants. The producer has to be worked as cold as possible, consistently with the reactions which take place in it. Gasification cannot occur properly below about 600 deg. Cent., but any temperature materially in excess of this means a poorer quality of gas and a waste of heat. In the boiler furnace, on the other hand, the burning of everything combustible has to be rapid and complete. Reasons of economy dictate the reduction of excess air to a minimum and, hence, temperatures of 1300 deg. Cent. or over are not uncommon. They are, indeed, regarded as a necessary consequence of proper working. Nevertheless, many engineers would be glad if they were lower, for burnt grates, melted refractories and unmanageable clinkers are often the price that has to be paid for them. It is to make things easier for the furnaces, and particularly for the grates, that the idea of mixing a proportion of flue gases with the primary air has been revived in some quarters. Steam has, for many years, been regularly blown in under the grates of internally fired boilers, mainly to assist the draught, but, almost certainly, to the benefit of the fire-bars themselves. The steam is decomposed by the burning fuel immediately above the bars, with a pronounced cooling effect, the heat so abstracted being restored by the combustion of the hydrogen above the fuel bed. An analogous procedure would be out of the question in large power-house boilers, for the loss of the whole of the latent heat in the steam, which it necessarily involves, could not be tolerated on grounds of economy. The introduction of flue gases in place of steam, however, is not open to this objection. The carbon-dioxide, the only active ingredient they contain, would cool the fires, like steam, by the extraction of the heat required for its decomposition. The effect can be readily calculated. Every gramme-molecule of the dioxide passing through the grate would take into combination one gramme-molecule of carbon, cooling the fire to the extent of 39 calories by the heat absorbed in the process. Two gramme-molecules of carbon monoxide would be formed, and these, on meeting the secondary air, would burn to two gramme-molecules of dioxide, thereby liberating 136 calories. The net result would be the addition to the furnace heat of 97 calories, the exact quantity which would have been liberated had the carbon in the fuel been burned directly to carbon dioxide by air in the ordinary way. Except for the possible practical advantage of cooling the fire-adjacent to the grates and restoring the heat so abstracted, to the interior of the furnace, there would, so far, seem neither gain nor loss by the process. But there are other things to consider besides the chemical reactions. The decomposition and recomposition of the carbon dioxide leave its final volume unaltered, so that for every cubic foot of it delivered under the grates another cubic foot has to pass through the furnace, the boiler and the flues in addition to that produced by the combustion of the fuel. This might not be so serious if carbon dioxide alone were in question; but, associated with it, in ordinary flue gas, is about six or seven times as much nitrogen. The latter, of course, is absolutely inert, and if rejected at its initial temperature, the only effect it could have would be to absorb heat in the furnace to deposit it again amongst the tubes. The boiler would have to deal with the gases produced by combustion, together with the quantity of flue gas returned to the grates. The stack, on the other hand, would only carry away the quantity of gases normally produced, so that the whole system reduces itself to the continued circulation of a large volume of extra gases through the grates, the furnace, the boiler unit and back again.

Regarded merely in this light, and neglecting the cooling effect of the carbon dioxide on the grates, referred to above, there may be something to be said for it. Indeed, the advocates of high gas velocities to promote turbulence and to increase rates of heat transmission, may find a good deal in favour of the scheme. But high gas velocities mean increased fan power with no corresponding gain in boiler output in this case, while velocities through the fuel bed are limited by the risk of blowing unburned particles and ash out of the furnace. In gas producer practice the principle of passing a part of the gases leaving the metallurgical furnaces back through the producer has been generally condemned after serious trial, the main reason being the reduction in the calorific value of the gas from the producer on account of its heavy dilution with nitrogen. It seems possible that this feature might also be disadvantageous in a boiler furnace, though the cases are by no means parallel. Boiler furnaces are quite hot enough as it is, for the melting of iron and steel is just what they are not wanted to do. Indeed, many engineers would be happier if they were a little cooler. If this can be brought about without loss of efficiency by carrying their excess heat among the boiler tubes, where it could be abstracted by improved convection, the cost of extra ducts and fan power will hardly be grudged. Provided that combustion can be properly completed by the secondary air in the presence of a heavy excess of nitrogen, the principal remaining question would seem to be whether the increased convective effect of the gases counterbalances the diminished radiation effect in the furnace. Whilst, as reported above, several boilers using the system are already in operation we have been unable to find any record of the results. In view of the revived interest in the subject we trust that the publication of figures will not be long delayed.

## Obituary.

### GEORGE J. MASSEY.

WE regret to have to record the death, on July 14th, of Mr. George J. Massey, manager of the engineering departmentat the Erith Works of Callender's Cable and Construction Company, Ltd. Mr. Massey received his training in the office of his brother-in-law, Mr. Roland Woolaston, of Manchester, and after a period in the drawing-office of Isaac Storey and Sons, of Old Trafford, at the age of twenty-four he entered the service of Callender's Company in 1902. After spending about a year in the inspection department, he was transferred to the drawing-office, of which he took charge in 1914. Later, he became assistant to Mr. Edgar Loam, the engineering manager, and succeeded him in 1920. For a time he also had charge of the plant department. He was a very popular member of the company's staff, and took a keen interest in the social and sporting life of the works. Apart from his popularity at Erith, he was known and respected by many connected with the electrical industry in different parts of the country.

### ARTHUR WRIGHT.

BY the death of Mr. Arthur Wright, which occurred on Tuesday last, the electrical industry has lost one of its most prominent pioneers. Although originally intended for the medical profession, electricity soon attracted his attention, and he began to study electrical engineering. In due course he became chief engineer to the Brighton and Hove Electricity Supply Company and subsequently engineer and manager to the Brighton Corporation undertaking, which, under his guidance, became a conspicuous success. He was responsible for the Portslade generating stations and for many progressive steps in connection with electricity supply at that popular seaside resort. Many years ago, however, he retired from Brighton and took up consulting work, in which he was also eminently successful. During the years 1889–1906 he acted as consulting electrical engineer to the Stepney Borough Council; he was also engaged in advisory capacity by the Marylebone Borough Council and by various undertakings abroad, including one in South America. Until three years ago he was making visits to Boston, U.S.A., twice a year as consultant to the Boston Edison Company. He was the founder and first President of the I.M.E.A. and the inventor of the well-known maximum demand indicator. For many years he was a member of the Institution of Electrical Engineers, although by reason of his busy life he seldom attended the meetings.

## Literature.

### SHORT NOTICES.

*Revised Heat Drop Tables* (1931), Calculated by Herbert Moss, from the new data and formulæ of the late Professor H. L. Callendar. Published for the British Electrical and Allied Industries Research Association by Edward Arnold and Co., London. Price 12s. 6d.—It is impossible to review tables such as these, and we shall serve our readers best by quoting the first two paragraphs of the Preface, in which their nature and the reason for their appearance are described. We may add that the tables are clearly printed on quarto pages tabbed, for easy reference, with "Final Pressures." The paragraphs referred to run as follows:—"Heat drop tables based upon the system of steam equations formulated by the late Professor H. L. Callendar were published by the British Electrical and Allied Manufacturers Association in 1917 for a range of initial pressures from 50 lb. to 400 lb. per square inch, and further tables were published by the British Electrical and Allied Industries Research Association in 1925 for the range from 400 lb. to 2000 lb. per square inch. The values which were adopted for the properties of steam at the higher pressures were largely based upon extrapolation of experimental results obtained at lower pressures. Under the auspices of the Electrical Research Association, Professor Callendar undertook and completed the measurement of the total heat of water and steam at pressures up to 4000 lb. per square inch and to temperatures of 750 deg. Fah. and his results have led to some modification of the accepted values at the higher pressures. His report with skeleton tables has been published in the *Proceedings* of the Institution of Mechanical Engineers, May, 1929. The Heat Drop Tables comprising this volume have been calculated in conformity with this new knowledge from data supplied by Professor Callendar and they are intended to supersede the tables mentioned above. In the Revised Heat Drop Tables, the adiabatic Heat Drop of 1 lb. of steam is tabulated in British Thermal Units for initially dry saturated or superheated steam of pressures from 100 lb. to 3200 lb. per square inch gauge. The initial temperature conditions, which were stated in the old tables in degrees of superheat, are now given simply in degrees Fahrenheit of temperature. Thus the initial conditions are specified in the same manner as they are measured, viz., by means of gauge pressure and temperature. Values of the Heat Drop are tabulated for intervals of initial temperature of 25 deg. Fah. up to 1000 deg. Fah. at all pressures. The final pressures range from 27in. to 29·5in. of mercury vacuum, corresponding to absolute final pressures of 3in. to 0·5in. of mercury. A table for low-pressure dry saturated steam—14 lb. to 19 lb. per square inch, absolute—is also included. Interpolation between the values for tabulated initial pressures, initial temperatures and final vacua may lead to an accumulation of small errors, but in all cases the required value for any specified conditions should be obtained with an error of less than 0·1 British Thermal Unit. To attain this degree of accuracy, the tabulated values have been calculated in such a manner that there should be no errors in them greater than 0·02 British Thermal Unit."

*Electrolytic Conduction.* By F. H. Newman. London: Chapman and Hall. Price 25s.—The author of this book makes an attempt to give the reader some idea of the fundamental conceptions underlying the ionic theory, more particularly as applied to the passage of electricity through electrolytes, a subject, he explains, which has attracted the attention of physicists and physical chemists for many years. During the past six years Debye and Hückle have formulated a theory which, under certain conditions, satisfactorily accounts for the electrical conductance of strong electrolytes, and the success which attended their efforts has stimulated other workers to make a more detailed study of the subject. The author points out, however, that workers in this field still remain without a clear conception of why an electrolyte, in the first instance, should dissociate, and that an explanation is not likely to be forthcoming until many more very accurate measurements have been made of the properties of electrolytes, both in aqueous and non-aqueous solvents. The known facts and experimental data relating to electrolytic conduction have been collected by the author, and are presented in this book, together with the theoretical views which serve to connect them in an ordered sequence. Since the use of modern thermodynamic methods is extending to almost all branches of the subject, and since such methods may be unfamiliar to some students, an introductory chapter has been introduced explaining all

# KEARSLEY POWER STATION—LANCASHIRE ELECTRIC POWER COMPANY

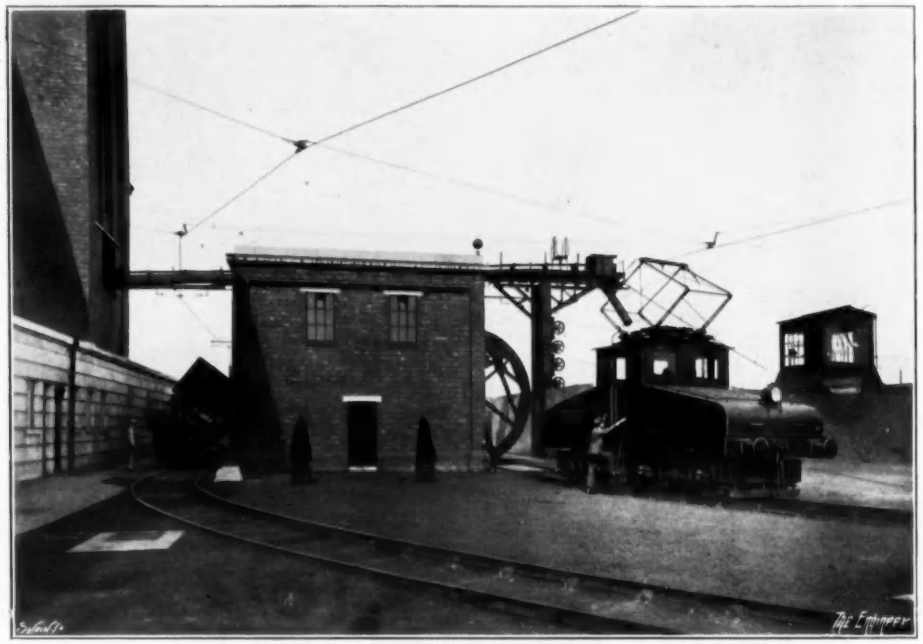

FIG. 4—COAL-TIPPLER HOUSE AND ELECTRIC LOCOMOTIVE

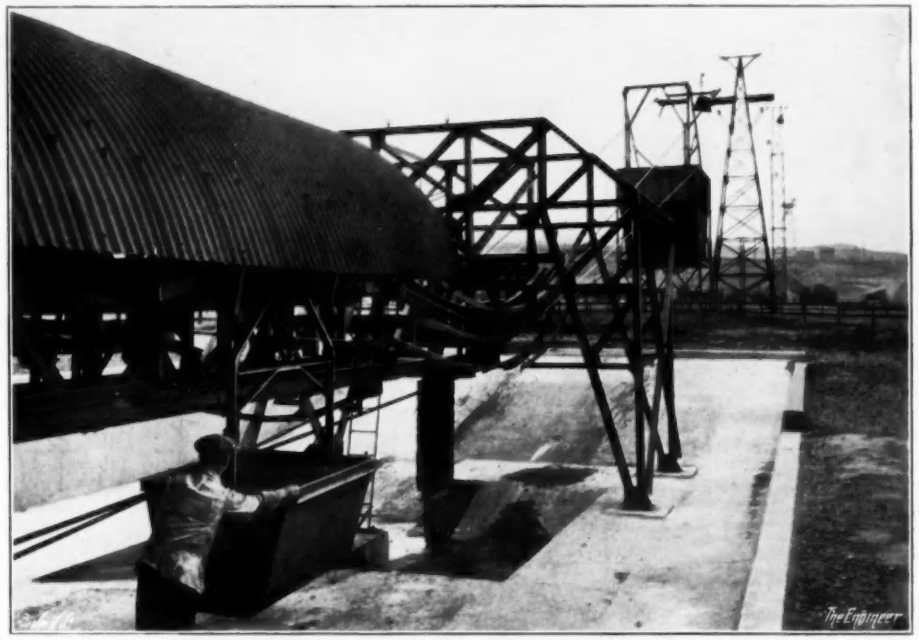

FIG. 5—ASH-SKIP AT TERMINAL OF AERIAL ROPEWAY

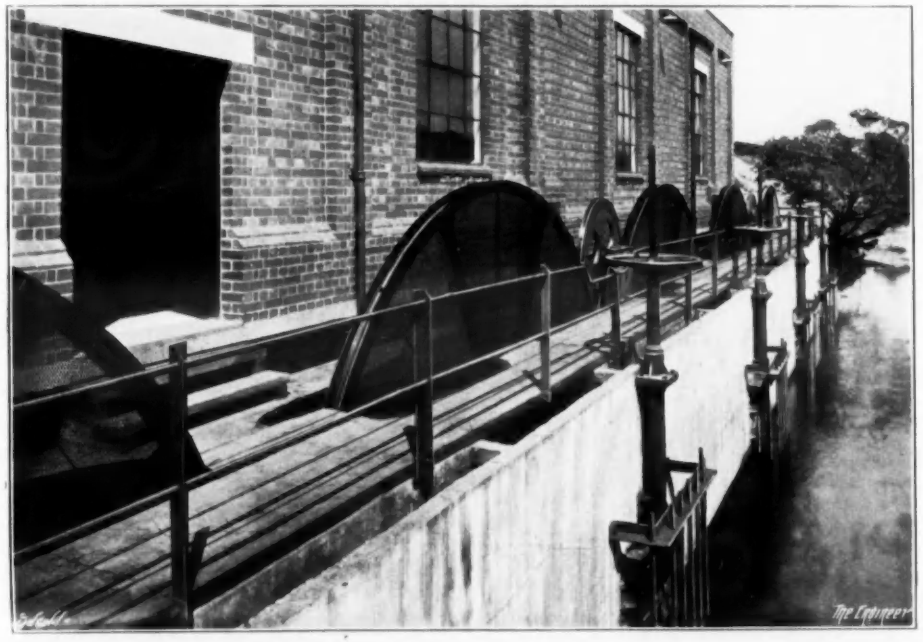

FIG. 6—SCREENS AT INTAKE OF CIRCULATING WATER

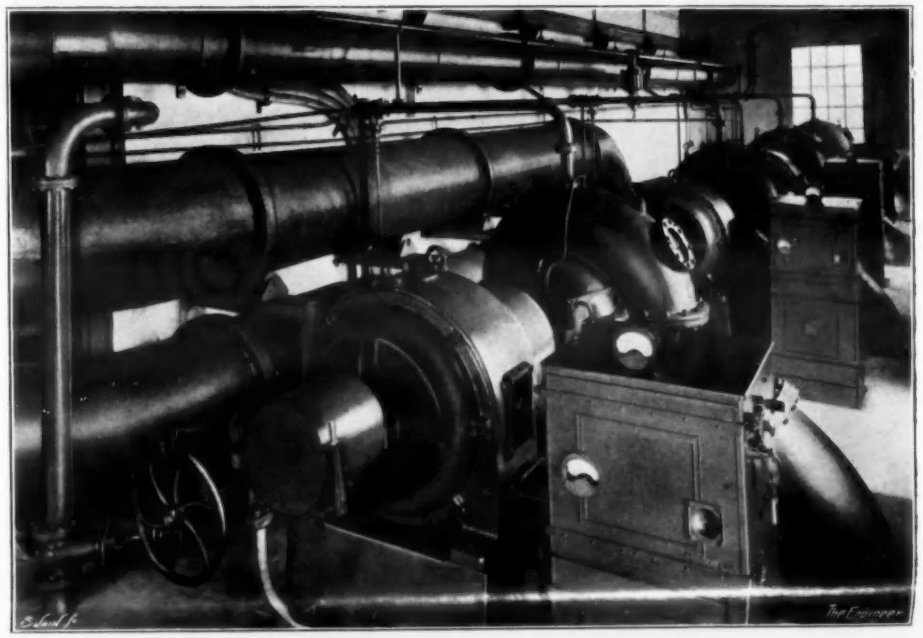

FIG. 7—INTERIOR OF PUMP HOUSE

FIG. 6 SCREENS AT INTAKE OF CIRCULATING WATER

FIG. 7 INTERIOR OF PUMP HOUSE

FIG. 8—VIEW OF FIRING AISLE

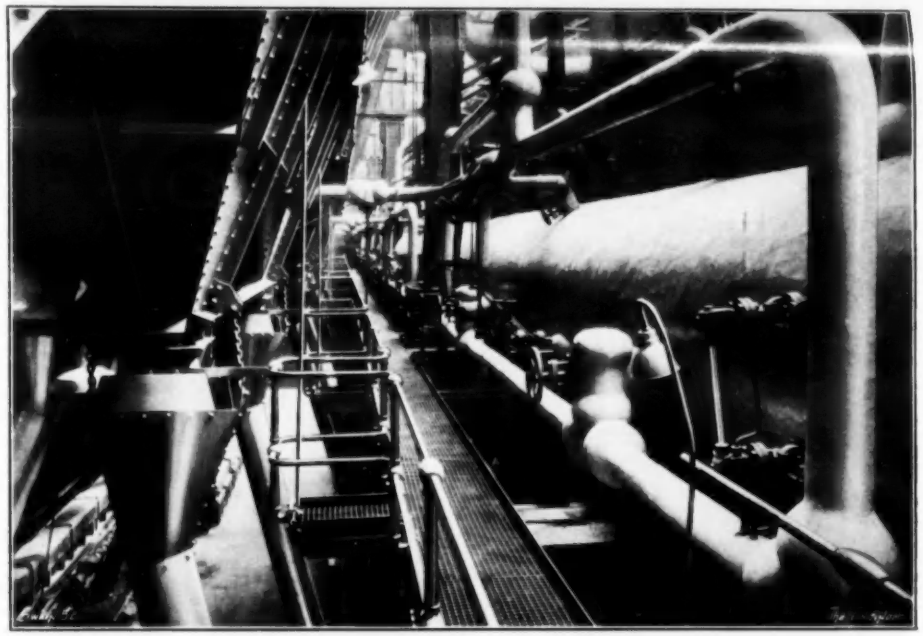

FIG. 9 GALLERY AT LEVEL OF BOILER DRUMS

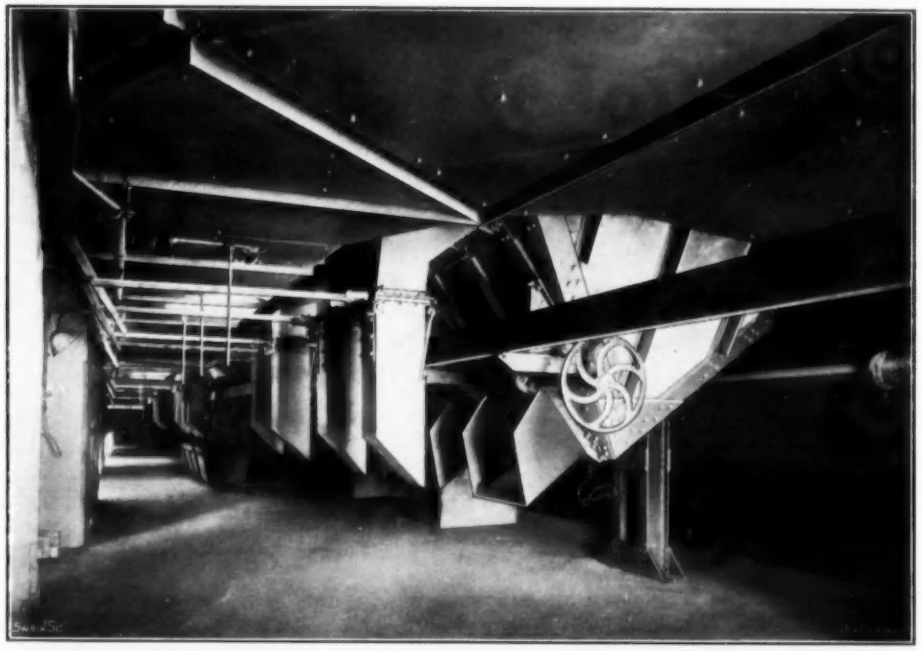

FIG. 10—ASH SHOOTS IN BASEMENT OF BOILER HOUSE

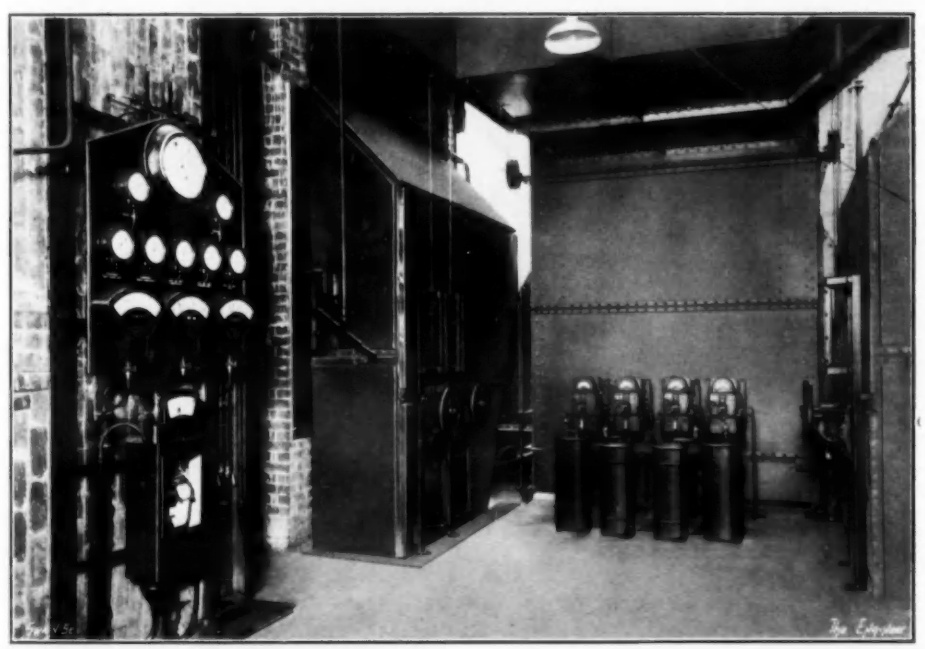

FIG. 11—VIEW BETWEEN A PAIR OF BOILERS

UNIV. OF MICH.

the thermodynamic principles which are applied to the work. The following chapters are chiefly devoted to the properties of electrolytic solutions, aqueous and non-aqueous, and a fairly full account of the modern theories of electrolytic conduction is given, especially that of Debye and Hückle, which has not hitherto appeared in English. In addition to the theoretical views and the known facts, the more important experimental methods used in determining these facts are described, and in the last chapter a brief account is given of the technical applications of electrolysis.

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*Charts and Data on Marine Boiler Design.* By H. C. Walker, M. Inst. N.A., M. Inst. Mar. E. London: Chapman and Hall, Ltd. 1931. Price 25s.—The marine boiler is in the fortunate position that all the leading authorities have agreed upon a set of rules for its design. Since that agreement was reached, some ten years ago, "The Standard Conditions for the Design and Construction of Marine Boilers," published by H.M. Stationery Office, has governed marine boiler practice. Mr. H. C. Walker, a Board of Trade Surveyor, has had the happy idea to translate all the formulæ into simple charts so as to enable any expression to be read direct and without calculation. The charts are of large size, about 12in. by 8in., done in draughtsman's style and excellently clear. Opposite them are given the formulæ on which they are based, with worked-out examples. The whole book is thumb-holed for quick reference and is printed on a thick paper, which should stand plenty of knocking about. We have no doubt that it will be found very acceptable to surveyors, designers, inspectors, draughtsmen and others engaged upon marine boiler design.

## SIXTY YEARS AGO.

In September the British Association will be celebrating the centenary of its establishment. That fact lends added interest to an article in our issue of August 4th, 1871, in which an account was given of the manner in which it came into existence and of the way in which it had carried out its founder's intentions. Between 1826 and 1831 there had been much discussion concerning the low state of science in Great Britain and the lack of national encouragement to scientific men. Prominent among those taking part in the discussion were Sir Humphrey Davy, Sir John Herschel, and Sir David Brewster. It was Sir David Brewster who conceived the idea of an annual meeting of scientific men, and when he wrote, on February 23rd, 1831, to Professor Phillips, secretary of the Yorkshire Philosophical Society, suggesting that the meeting should be held at York, he, in effect, founded the British Association. Support for the idea was received from many quarters, and when the meeting opened at York on September 26th, under the presidency of Lord Milton, 353 people assembled to promote the scheme. In the minds of the originators, two of the principal objects which the Association should seek to achieve were the repeal or reform of the Patent Laws, and the attainment of some measure of direct national encouragement for science and its cultivators. As an outcome of the York meeting, however, many other subjects of interest took a prominent part in its activities. For the meeting at Oxford in the following year sub-committees were appointed to receive reports on the progress of astronomy, on the tides, meteorology, radiant heat, thermo-electricity, optics, mineralogy, geology, chemical science, and the history of the human species. The new body, although actively supported by most of the contemporary scientists, did not escape all opposition. *The Times* newspaper was hostile to it until 1852, and many theologians fulminated against the dangers of "peripatetic philosophy." In the early days the Association was a close and exclusive body, to which only philosophical people were elected in accordance with stringent rules. In 1838 at the Newcastle meeting, ladies were for the first time admitted to hear the discussions, and soon afterwards, although the original rules were allowed to remain on the books, it was permissible for anyone to attend the meetings on payment of a pound. The meeting of 1871 was held at Edinburgh under the presidency of Sir William Thomson (Lord Kelvin) and with Professor Fleeming Jenkin in the chair of Section G (Engineering). A considerable degree of excitement was caused on that occasion by attempts made to introduce spiritualism as a subject for discussion. Two of the sectional presidents had attacked the spiritualists, and Mr. (Sir William) Crookes had replied by handing in to Section A an account of experiments on "psychic force," which he had made by means of self-registering instruments. Mr. Crookes' paper was referred to Mr. (Sir) G. G. Stokes, then secretary to the Royal Society. Mr. Stokes reported that the subject seemed to have been investigated in a philosophical spirit, but he could see little use in allowing it to be discussed in the crowded sectional meetings. He suggested that a small committee might be appointed to investigate the questions discussed by Crookes, but he declined himself to serve on that committee.

## Letters to the Editor.

*(We do not hold ourselves responsible for the opinions of our correspondents.)*

### LOCOMOTIVE TESTING.

SIR,—From the discussion which followed Mr. H. N. Gresley's paper on "Locomotive Experimental Stations," it appears that there is often difficulty in maintaining a constant speed when a locomotive is run on a testing plant, and that, owing to the absence of road vibration, the boiler does not steam so freely as when in motion. On the other hand, successful results have been obtained from tests on the road, where a suitable length of line was available. It is not easy, however, to find a line of sufficient length and uniformity of gradient to permit of any protracted testing or to clear the line of ordinary traffic for the purpose of carrying out a test, and the natural suggestion is therefore to make a circular testing track on level ground.

If this were done, tests of indefinite length might be run—at least up to the water capacity of the locomotive's tender—under constant conditions of loading except for differences due to the change in relative wind as the train ran round the track. Even this effect, provided the actual wind were not excessive, might average out to something approaching normal conditions during the complete circuit. There would also be the great advantage that the locomotive would be subjected to exactly the same conditions of vibration and air flow past chimney and ashpan as in its working life—conditions difficult, if not impossible, to simulate in a testing plant.

The main disadvantage of the scheme would appear to be that of high initial cost in comparison with a testing plant, as, in order to reduce curvature effects at high speed to negligible proportions, a track 2 or 3 miles in diameter would probably be necessary. There are also the slighter defects that it would be impracticable to collect the ash discharge from the chimney, and that it might be more difficult to obtain accurate readings from the instruments when mounted on a moving vehicle than when at rest. So far as observations at the front end of the locomotive are concerned, however, the removal of normal loading gauge restrictions would make practicable a more commodious shelter than can be used for a main line test.

Against these disadvantages there has to be set the fact that, not only could the testing track exactly reproduce working conditions, but that it could be used for research impossible in a testing plant. For example, the rising qualities of a new locomotive design could be investigated at any required speed. Information could be obtained as to the drift of the exhaust steam, a point which has compelled considerable attention in recent years, and in this connection the difference in relative wind at various positions on the track would be a positive advantage. By fitting suitable instruments to the permanent way the track stresses produced by vertical and horizontal disturbance in the locomotive could be determined. This, again, is a matter which is becoming increasingly important owing to the modern tendency towards heavier axle loadings.

Lastly, the testing track would retain its utility whatever type of railway haulage agent came to be adopted, whereas it was suggested by one speaker at the discussion that the testing plant would become useless if steam were superseded by electricity.

W. A. TUPLIN, B.Sc.

Huddersfield, July 25th.

### THE SUD EXPRESS.

MONSIEUR LE DIRECTEUR,—Vous avez, dans votre numéro du 10 Juillet, publié un trés intéressant article sur les services d'été de trains rapides français.

Je me permets, ci-après, de compléter les renseignements que vous donnez pour un des trains signalés, "Le Sud-Express."

Vous faites remarquer qu'entre Paris et Bordeaux, ce train a une vitesse commerciale de 87 kiloms. 700 à l'heure, ce qui, pour un parcours de 587 kiloms. 4 est évidemment une performance remarquable. Mais au crédit du même train, il faut signaler que sa performance est encore plus digne d'être notée si on l'envisage sur le parcours Paris-Bayonne.

De Paris-Quai d'Orsay à Bayonne, la distance est exactement de 786 kiloms., soit environ 488 miles 5. Or, cette distance est franchie par le Sud-Express sur les réseaux du Paris-Orléans et du Midi, arrêts compris, en 9 h. 4 min., c'est-à-dire à une vitesse commerciale de 86 kiloms. 688 ou 53·87.

En réalité, d'ailleurs, la vitesse commerciale du Sud-Express est supérieure aux chiffres indiqués. En effet, si on veut, au point de vue technique, calculer sa vitesse commerciale vraie, il faut déduire de son parcours les 6 kiloms. du trajet entre Paris-Orsay et Paris-Austerlitz qui, d'après le tableau de marche, ne peuvent être franchis en moins de 8 minutes.

Dans ces conditions, si on ramène la distance au trajet Paris-Austerlitz-Bayonne, c'est-à-dire à 780 kiloms., on voit qu'elle est franchie en 8 h. 56 arrêts compris, soit à la vitesse commerciale de 87 kiloms. 312 ou de 54 miles 26, ce qui, ést évidemment, pour un parcours aussi long, le record au moins en Europe.

Sur ces 780 kiloms., les trajets Paris-Austerlitz-Les Aubrais et Bordeaux-St. Jean-Bayonne sont effectués par traction électrique. Mais il est à noter que ce n'est pas sur ces deux parcours que la vitesse est le plus élevée. C'est, en effet, entre les Aubrais et St. Pierre des Corps que ce train marche le plus vite. Les 111 kiloms. 9 sont effectués à la vitesse de 61·33 miles à l'heure, soit 98 kiloms. 680. Les locomotives employées sont du type Pacific P.O., 3.600 à vapeur surchauffée.

Veuillez agréer, Monsieur le Directeur, l'assurance de mes sentiments très distingués.

ANDRE BOURBON,
Rédacteur en chef du Service Technique de la Petite Gironde.

Bordeaux, 18 Juillet.

### RAILWAYS AND THE PUBLIC.

SIR,—One reads quite a lot regarding the attention our railway authorities are giving to obtain the support of the public, and whilst many of the innovations are good, they only touch the fringe of the matter. We are living in a "rush age," and people regard speed as the main object of life. We have to get more into a day than did our grandfathers, and this tendency of the present era is ignored by the railways. To-day I read that the French railways are testing out a rubber-tired vehicle, but even that will not bring the passenger traffic back.

Take any provincial town. Is there handy at street corners a time-table of the trains? No, so that if one does contemplate going by rail, it is often the case that on arrival at the station after ten or fifteen minutes' walk one finds the train has gone and the next is in one or two hours. The road omnibus has its time-tables up in villages, not necessarily those through which the omnibus will pass, and so it is convenient and quicker to travel by road. I have given up using the rail for journeys of about 150 miles or less, as I can beat the train with an Austin Seven or Twelve. My family has a liking for Folkestone, but it is a hopeless place for a business man unless he be one of those eleven-to-four directors; so I can leave that seaside place about 6 a.m. and be in town by 8 a.m. without any rush or excessive risk for an Austin Seven.

I have to go every three months to Chesterfield or Sheffield for a meeting, and I can leave South London at 7 a.m. and be in Chesterfield at noon. This is better than the train. I tested my business trip to the important towns in Scotland recently—1648 miles in a fortnight. My Austin Twelve averaged 30 miles per gallon of petrol, 800 miles per gallon of oil, and on this basis, taking four years for life of the car and its wear and tear—it is not hard on tires, as mine has already done 28,000 miles on the five covers and they are good for another 5000 at least—this with five passengers, gives an outside cost of 14s. each for 600 miles, against the railway basis of 1½d. per mile, 75s. each. The railways spend more on one coach than the cost of seven Austin cars, but what an inducement to passengers if the railways would offer a small car with six to ten people, running through to, say, Leicester every fifteen minutes, at a cost of 5s. or even 7s. 6d. each way and at a speed of an express train.

The railways at present aim at longer trains at fewer intervals, whereas it should be short trains at frequent intervals, so that people get away from time-tables and treat the main lines as they do the Underground—travel by it, knowing there will be a train soon, if not immediately. The roads could not compete with this and I should think it would be possible to invent some light wheel to fit a car; air tubes would not be necessary, as the rails would be so smooth with the present springing of cars. The railways would save their heavy cost on coaches and locomotives and give real service to the public, who would be compelled to give their support.

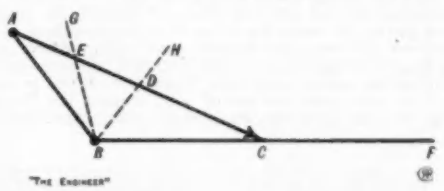
A TRAVELLER.

London, July 22nd.

### LINE AND ANGLE BISECTOR.

SIR,—The following simple contrivance may be found useful to draughtsmen and is, I think, novel.

A B and A C are two links hinged at A, A B being pivoted at B; A C is twice as long as A B. E and D are points on




A C such that D is midway between A and C, and E is midway between A and D.

If, now, the end C of the link A C be slid along B F, then H B will always bisect G B F, and E B will always equal $\frac{B C}{2}$. The arrangement is, of course, only an adaptation of Euclid, Prop. 3, Book 6.

H. R. KEMPE.

Betchworth, July 25th.

### SILICON STEEL.

SIR,—In your column of "Notes and Memoranda," on page 67 of your last issue, you state that the girders of a certain thirty-storey building in Kansas are of "silicon steel." This is said to have given a saving in cost of 7½ per cent. as compared with plain carbon steel. There seems, at present, to be a certain confusion as to what is meant by "silicon steel," and I believe the term is applied in various countries to very varied silicon content. One would like to know the analysis, &c., of the steel referred to. It would probably be difficult to standardise the silicon content to which such a name should apply.

HENRY.

July 27th.

### THE EFFICIENCY OF STEAM NOZZLES.

SIR,—As the event proves, it would have been well had the Nozzles Committee defined more fully the sense in which they meant to use the term "kinetic energy of the jet." The alternative definition, you suggest, may be regarded as satisfactory provided that the term "actual velocity" is replaced by "mean velocity," this mean velocity being deduced from the momentum of the jet and not from its discharge.

H. M. MARTIN,
Member of the Nozzle Research Committee.

Croydon, July 27th.

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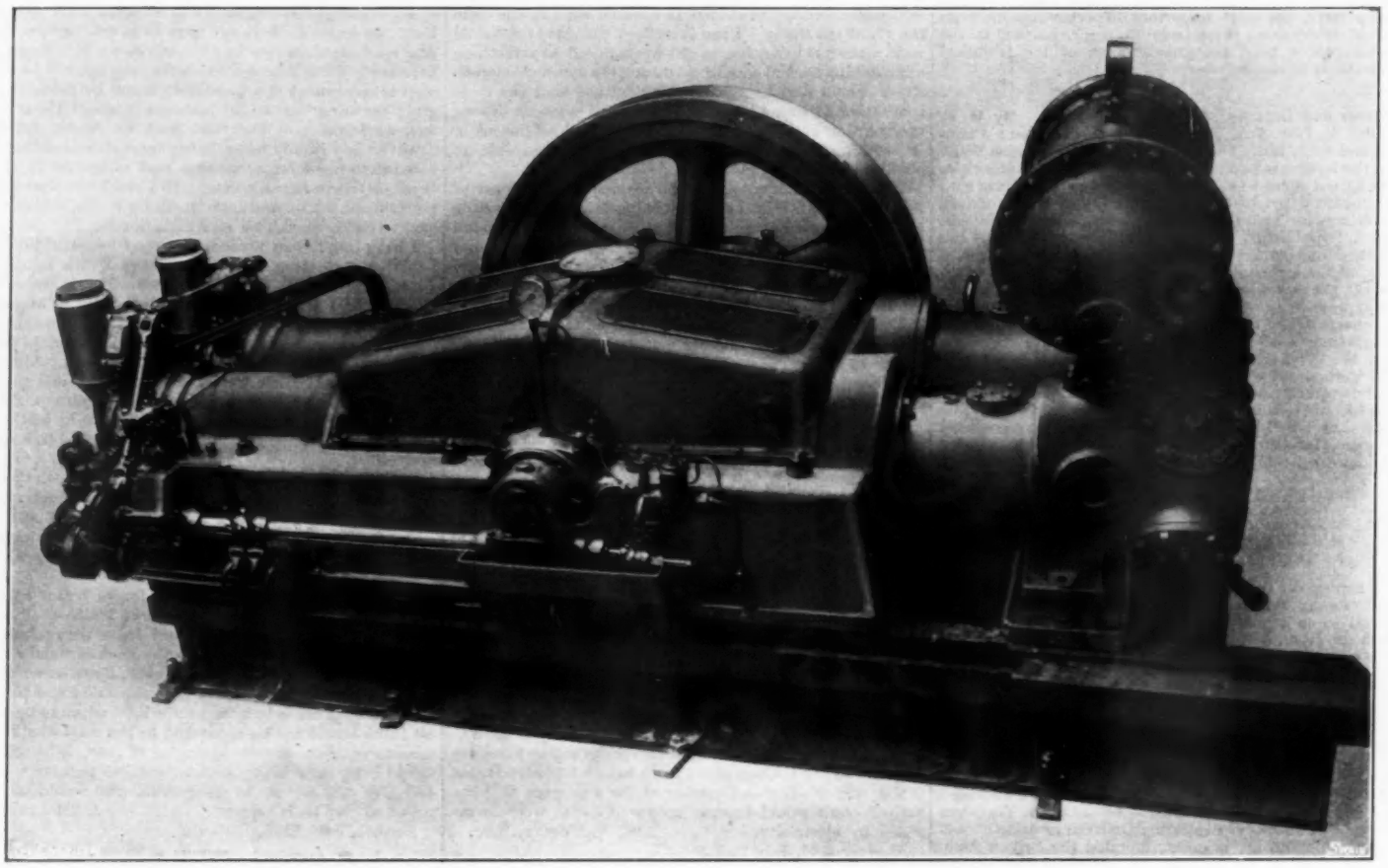
AN experimental plant for the extraction of benzene from natural gas has been installed at Calgary, Alberta. It is anticipated that some one and a-half million barrels of benzene can be recovered yearly, over and above a similar amount of naphtha.

# A NEW OIL ENGINE COMPRESSOR UNIT

ROBEYS, LTD., LINCOLN, ENGINEERS



## A New Oil Engine Compressor Unit.

THE increasing use of compressed air for a variety of purposes has led Robeys, Ltd., of Lincoln, to design and put on the market a range of oil engine-driven compressors of a very neat and compact type. Above and in Fig. 1 we reproduce photographs of a two-stage and a single-stage unit respectively. From these it will be seen that the new machines are of the "straight line" type. The working parts are completely enclosed and carried upon a base-plate which is common to both engine and compressor, strongly made of massive box section, reinforced by transverse ribs. The valve gear of the engine is operated from a layshaft at the side by means of an excentric and levers, and the fuel pump and governor gear, which are driven by the same layshaft, are mounted directly upon the bed-plate. In the case of the two-stage units an intercooler is fitted above the two compressor cylinders.

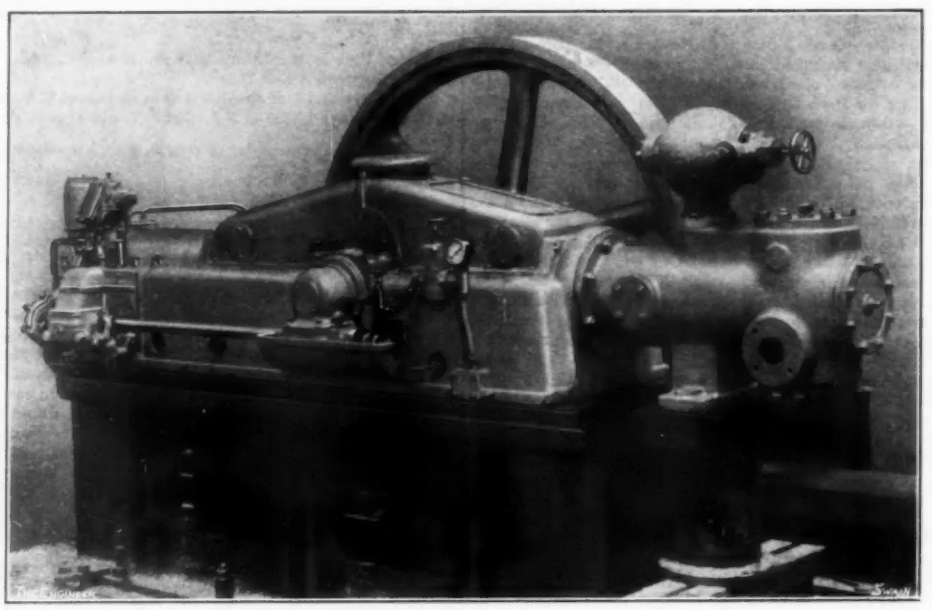


FIG. 1—SINGLE-STAGE COMPRESSOR

*The Compressor.*—Dealing first with the compressor end, a view of which will be found in Fig. 4, the cylinders are made as separate castings in a special alloy iron, resistant to wear, each being bolted to the end of the base-plate, while its weight is carried by a foot mounted on the sole-plate. The valves are arranged radially with the object of allowing unrestricted passage for the air, while at the same time ensuring that the clearance volume shall be a minimum, and enabling the heads to be water-cooled. The valve pockets also are surrounded by water. The valves themselves are of the Robey automatic disc type, having the special feature that no guide studs or other similar supports likely to suffer from wear are necessary. They are made of a special alloy steel and are kept in position by coiled springs of square section, which fit at one end into flanges on the outside edges of the valves and are secured at the other end by guard plates. Thus the valves are free to seat themselves accurately and noiselessly at every stroke, while at the same time, since there is no sliding friction to contend with, lubrication is unnecessary. Each is mounted as a single unit.

Large water spaces are a feature of the design of the compressor cylinders, the cleaning of which is facilitated by large doors on the sides and easily removable covers on the ends.

For regulating the amount of air delivered an unloader valve is mounted on the suction side of the compressor. This valve is fitted at the side in the case of two-stage units, and on the top of the cylinder for single-stage machines. It can be seen in the photographs reproduced in Figs. 1 and 4, and Fig. 2 is a sectional drawing. The air pressure in the final receiver operates the valve, the mechanism being as follows:—The hole A—Fig. 2—is connected directly to the receiver so that the air within it is always at receiver pressure. If this pressure tends to rise the cone valve B, which is controlled by the adjustable spring beneath it, is depressed and the air is admitted into the chamber beneath the piston-like portion of the main valve, which it lifts against the resistance of the control spring above the valve. The valve is thus closed and no air is admitted to the compressor. When the pressure in the receiver falls again the reverse action takes place. If desired, the valve can be operated by hand by means of the lever provided.

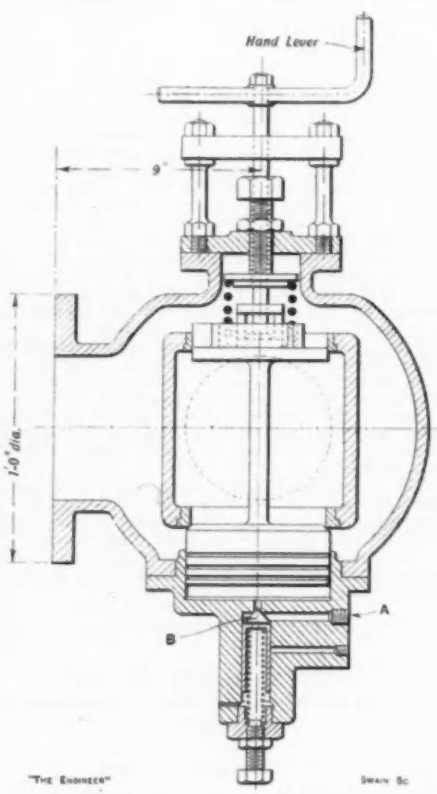
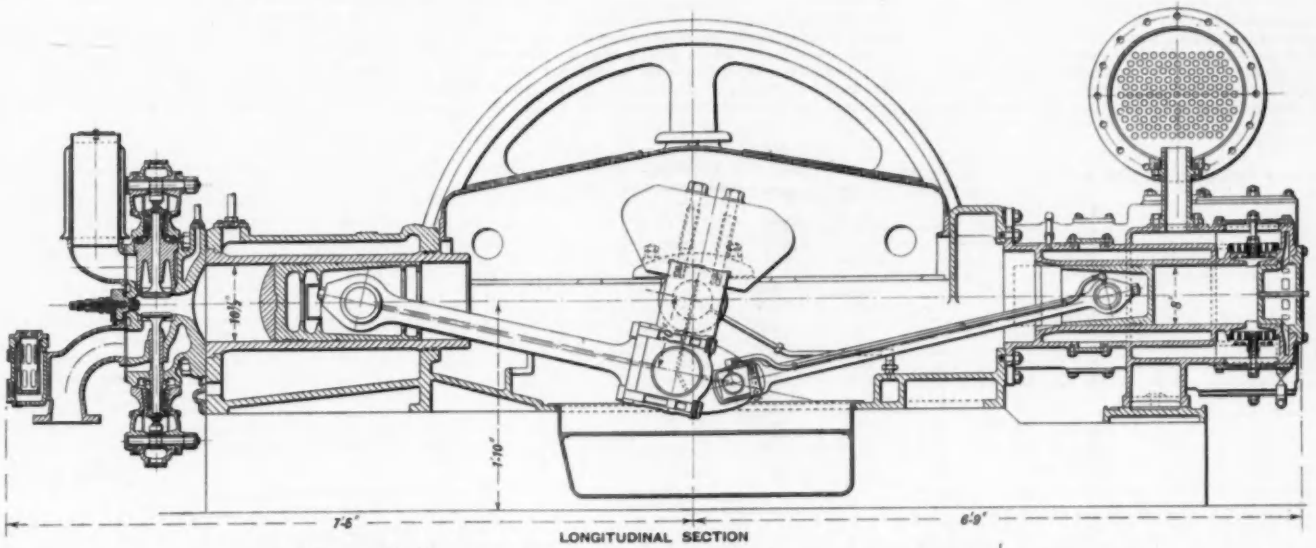


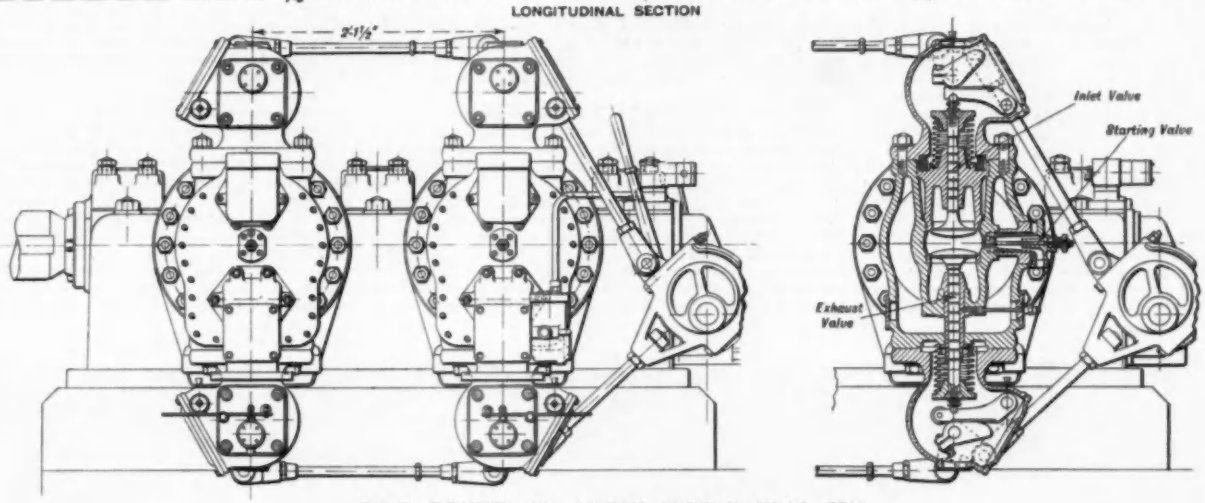

FIG. 2—SECTION THROUGH UNLOADER VALVE

*The Oil Engine.*—Like the compressor, the oil engine

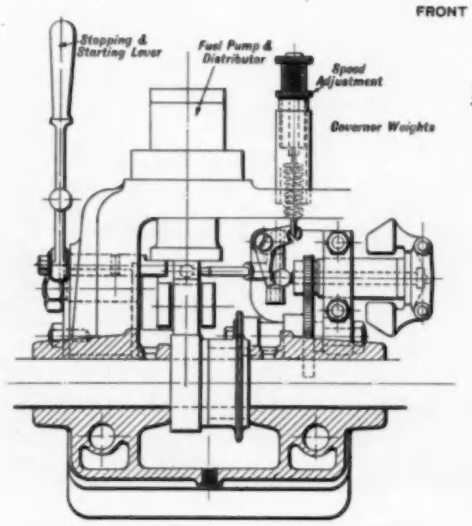
# A NEW OIL ENGINE COMPRESSOR UNIT

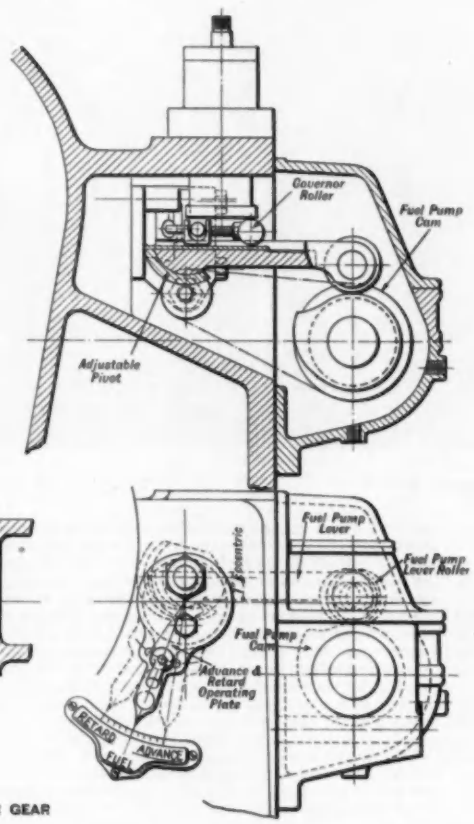


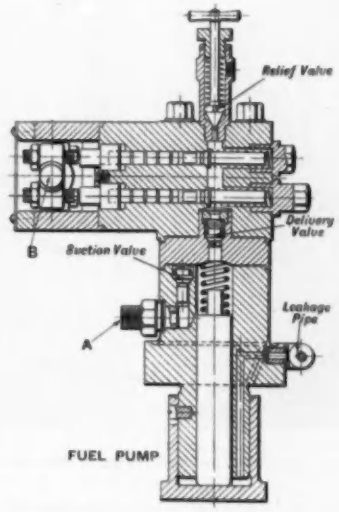

LONGITUDINAL SECTION



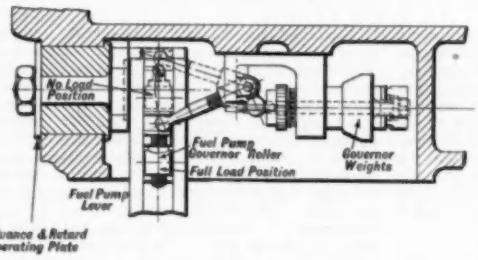

FRONT ELEVATION AND SECTION THROUGH VALVE GEAR



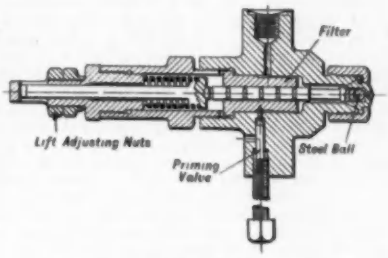




FUEL PUMP




GOVERNOR GEAR




STANDARD SPRAYER

"THE ENGINEER" BRAIN Sc

is similar in design to Robey's ordinary horizontal type. The longitudinal sectional end view and a section through the valves—page 125—show the main features of a machine capable of compressing 350 cubic feet of free air per minute. The engine has a stroke of 20in. and a bore of 10½in., and runs at 270 r.p.m. The overall dimensions of the machine are 14ft. 2in. in length by 9ft. 7⅜in. in width to the outside of the fly-wheel. The highest point is the top of the intercooler, 4ft. 10in. above the bottom of the base-plate. The base-plate and crank shaft are common to both engine and compressor, and at present articulated crank pins are provided to take the connecting-rods of the compressor. We understand that a design will shortly be brought out by which the big ends of the two connecting-rods will be fitted upon a single pin, which will bring about a saving of some inches in the overall length. The crank case is closed by a cast iron cover made in halves and provided with large inspection doors. A forced-lubrication system is embodied in the design, the oil being drawn from the bottom crank case by a gear pump and delivered *viâ* a manifold cast into the bed to the main bearings and big and small ends of all connecting-rods. A filter, which can be cleaned while the engine is running, is fitted on the delivery side of the pump. The system can be primed by hand before starting.

The breech-ends of the cylinders are made of heat-treated alloy cast iron, and are so designed that there are no ties between the hot combustion chamber walls and the cool jacket walls which might cause strains to be set up, while the water spaces are closed by steel breathing plates. The shape of the combustion chamber can be deduced from the views included on page 125, from which it will be seen that there are no dead air pockets, while it is so designed that turbulent flow of the air is caused when the piston approaches the top dead centre. Each cylinder liner is a separate component. Pressure and water joints are made by the clamping action of the breech end, while the other end is free to expand longitudinally. No connection exists between the cooling spaces around the cylinder walls and those around the breech end. The engine pistons are made of alloy cast iron and have circular stiffening ribs to ensure freedom from distortion. Loose ends, insulated from the body, are fitted to keep them cool.

*The Valves and Valve Gear.*—The valves obtain their movement from the lay shaft through an excentric and push-rods. The mechanism by which rapid opening and closing is obtained can easily be followed by reference to page 125. For double-stage units links are fitted connecting the valve gear of the second cylinder to that of the first, so that all may be driven by the same excentric. In this case the rolling levers of the second cylinder are fitted in the hand opposite to that of the first.

The inlet and exhaust valves are fitted with double springs, as can be seen on page 125. The safety valve is incorporated in the inlet valve, the whole cage lifting against the pressure of the large square section spring if there is any unduly great pressure in the cylinder. An extra large release port is obtained by this device. The valve levers are enclosed in oil baths and the valves themselves are made of heat-treated nickel alloy steel forgings.

*The Fuel Pump, Governor, and Sprayer.*—On page 125 a section through the combined fuel pump and distributor is given, while the photograph reproduced in Fig. 3 gives some idea of its external appearance and the method of attachment to the engine above the lay shaft. A guide is fitted at the bottom of the pump with the double purpose of relieving the plunger of any side thrust and returning any oil leaking past it to the fuel tank *viâ* the leakage pipe. Fuel enters at A, passes through the mitre type suction valve and is delivered through a similar valve to the distributor above. The valves of the distributor are operated by the rocker cam B and are opened and closed several degrees before and after the pump delivers the fuel. The rocker cam is moved by an excentric and lever driven by the lay shaft. This mechanism can be seen in the engraving. At the top of the distributor there is a large relief valve.

The governor gear, which is of considerable interest, is illustrated on page 125. The governor weights are driven from the lay shaft by a chain through a spring coupling. This method of drive is designed to protect the governor from the torsional spring of the lay shaft at the moments when the fuel pump and the valve gear are being operated. The movement of the weights pushes a rod running down the centre of the governor shaft against the shorter arm of a bell-crank lever. On the other arm of the bell-crank there is a ball running in a U-shaped cup to which is attached a roller movable along the plane formed by the top of a lever. This lever is supported at one end in a cup and has a roller at the other end resting upon a cam fitted upon the lay shaft. The roller fits between the lever and the bottom of the fuel pump. Since the lift given by the cam to the end of the lever is constant, the length of stroke of the fuel pump depends upon the degree to which the roller approaches or recedes from the fulcrum of the lever, while the period of opening and the time of opening always remain the same. To suit various grades of fuel the moment of injection can be altered while the machine is running by shifting the operating lever horizontally over the face of the cam. This adjustment is made by means of a banjo plate attached excentrically to the pivot of the cam lever in the manner shown in the drawing.

The governor mechanism is totally enclosed and runs in oil. It is designed to give a momentary "kick" from full load to no load of less than 5 per cent. increase in speed with a permanent variation of less than 3 per cent. Alteration of the speed of the engine while running can be effected by resetting the tension of the governor spring, which acts upon the end of the governor rod through a bell-crank lever, by means of the hand screws provided.

A section through the sprayer is also shown. A filter is incorporated in this design. The plunger guide, which is renewable, is screwed on the outside. Several grooves are milled longitudinally across the threads, starting alternately from the bottom and the top, but not reaching the full distance along the threaded portion. In consequence the oil has to find its way through the threads from one groove to the next. A hardened steel ball is mounted at the end of the plunger, finding a seating on the nozzle. It has a certain amount of freedom to move both laterally and longitudinally, so that it can take up any slight misalignment. At the moment of delivery the oil pressure holds it upon its seating until the plunger has moved a sufficient distance outwards, with gathering velocity, to pick it off, with the consequence, it is claimed, that a very sharp lift is obtained, giving sudden injection and high fuel velocity. The nozzle itself is provided with two holes so that the fuel is sprayed in a fan form suitable to the shape of the combustion chamber. The injection pressure can be varied at any time by means of the external adjustment, while the lift can also be seen and altered without difficulty while the engine is running. A priming valve is provided.

We saw one of these sprayers on test, using fuel oil, and observed that the injection was very sharp and rapid and that even on very light loads no drip occurred.

*Test Results.*—We had recently the opportunity of witnessing a test at the makers' works of a two-stage type compressor capable of compressing 350 cubic feet of free air per minute. The machine ran very quietly and smoothly and the exhaust could only faintly be discerned against a dark background. In the table above some figures are given.

Reckoning from such figures the makers claim that 16,000 cubic feet of free air can be compressed to a pressure of 100 lbs. per square inch for less than a shilling.

*Oil Engine Compressor Test Sheet.*

Rating of machine, 350 cubic feet per minute; barometer, 29·82 Hg; fuel, B.P. Diesoleum; specific gravity, ·875; calorific value, 19,200 B.Th.U. per lb.; flash point, 175 deg. Fah.; date, April 22nd, 1931.

| Time. | R.p.m. | Oil pressure. | Temperatures, deg. Fah. | | | | | | | Air pressure, pounds per sq. in. | | Fuel, lb. per half-hour. | Cubic feet of air per min. | Lb. of fuel per 1000 cub. feet. | Remarks. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Exhaust. | | Water. | | | Air. | | | | | | | |
| | | | 1 | 2 | Inlet. | Outlet engine. | Outlet compr. | Inlet. | Orifice. | Inter cooler. | Re-ceiver. | | | | |
| 7·3 | 270 | 16 | 670 | 680 | 53 | 125 | 82 | 58 | 114 | 23 | 100 | | | | |
| 8·33 | 270 | 16 | 660 | 680 | 53 | 115 | 80 | 60 | 141 | 24 | 100 | 15½ | 378 | 1·33 | |
| 10·3 | 270 | 16 | 665 | 675 | 53 | 108 | 83 | 63 | 144 | 24 | 100 | 15½ | 375 | 1·35 | |
| | 270 | 16 | 665 | 681 | 53 | 113 | 84 | 60 | 137 | 24 | 100 | 15¼ | 373 | 1·36 | Average of ½-hourly readings for 3 hr. |
| 10·4 | 270 | 17 | 640 | 660 | 54 | 115 | 75 | 63 | 125 | 23 | 80 | | 376 | | |
| 11·33 | 270 | 16 | 630 | 645 | 54 | 116 | 74 | 63 | 126 | 23 | 80 | 14½ | 375 | 1·24 | |
| 1·3 | 270 | 15 | 625 | 640 | 55 | 111 | 77 | 63 | 128 | 23 | 80 | 14½ | 378 | 1·24 | |
| Total 6 hr. | 270 | 16 | 627 | 646 | 54 | 115 | 75 | 63 | 124 | 23 | 80 | 14 7/8 | 377 | 1·25 | Average of ½-hourly readings for 3 hr. |

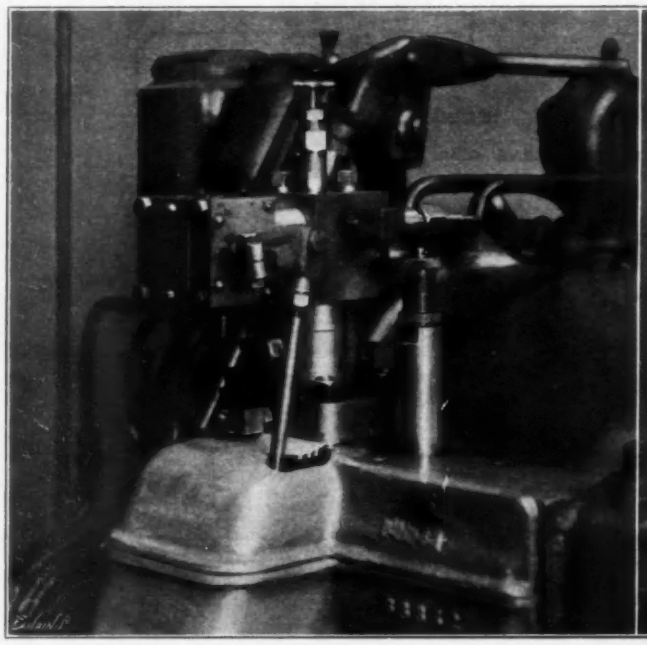


FIG. 3—EXTERNAL VIEW OF THE FUEL PUMP

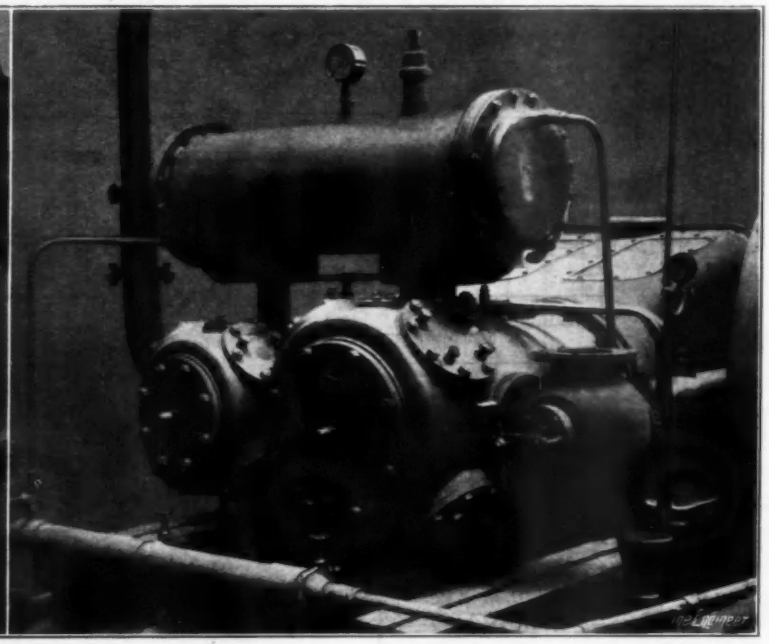


FIG. 4—THE COMPRESSOR END OF A TWO-STAGE UNIT

When the six-hour test was concluded the ability of the engine to run at slower speeds and with a variety of load conditions was demonstrated. The outlet of the air from the receiver was nearly closed, so that the compressor had only to make up a small leakage and the unloader valve was brought into play. The variation of pressure in the receiver was barely noticeable on the dial of the gauge, while the action of the unloader valve and governor resulted in the engine providing on each occasion that the valve opened only three or four working strokes. When the outlet valve of the receiver was operated to give a wide range of load the air pressure was regulated to give a variation of only about 3 lb. per square inch.

The compressor is made in a number of sizes ranging in capacity from 100 to 750 cubic feet of free air compressed per minute. The makers claim that it is the only straight-line oil engine compressor made in this country. We understand that already a considerable number of orders have been received and several machines are giving a satisfactory account of themselves in service.

## Trial Results of Exhaust Turbine Installation on s.s. Kingswood.

IN our issue of February 6th an equipment of low-pressure exhaust steam turbine and gearing designed to work in association with the existing reciprocating machinery as installed in the single-screw cargo boat "Kingswood," belonging to the Joseph Constantine Steamship Line, Ltd., of Middlesbrough, was fully described and illustrated.

The trials of this vessel and the results obtained since she was placed on service have fully justified expectations, and the following observations on the performance of the combined machinery will be of undoubted interest to shipowners, superintendent engineers, and marine engineers generally.

The exhaust turbine installation was, it will be recalled, constructed and fitted on board the vessel by the Parsons Marine Steam Turbine Company, Ltd., of Wallsend-on-Tyne, who guaranteed to the owners that with the combination of the low-pressure turbine the total power obtainable would be at least 20 per cent. greater than that with the existing reciprocating machinery for the same steam consumption; that is to say, that the power would be increased from 1750 to 2100 I.H.P.

It should be borne in mind that the reciprocating engines of the "Kingswood" were in themselves very economical. The vessel was built in 1929, and the machinery embodied several up-to-date principles, including the employment of superheated steam. Little or no advantage, therefore, was likely to be gained by any overhaul of the engines.

Very careful and exhaustive trials were carried out with the vessel before being placed on service, and the accompanying table gives the results obtained on those trials, with and without the turbine in use. The figures shown in

*Trial Results of Exhaust Steam Turbine Installation in s.s. "Kingswood."*

| Trial number | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| Date | April 22nd, 1931 | April 23rd, 1931 | June 16th–17th, 1930 | May 6th, 1931 |
| Type of trial | Progressive | Progressive | Voyage, Montreal–Oran | Progressive trial off Swansea |
| Turbine | Disconnected | In use | Original reciprocating engine before alteration | Turbine in use |
| Draught | Forward 8ft. 2in., Aft 16ft. 5in. | | Loaded | Loaded |
| R.p.m. | 66·27 | 72·55 | 62·6 | 67·40 |
| S.H.P. | 1598 | 2080 | 1603 | 2021 |
| Water, lb. per hour— | Per S.H.P. | Per S.H.P. | Per S.H.P. | Per S.H.P. |
| Main engines | 20,820 .. 13·028 | 20,400 .. 9·807 | 20,250 .. 12·624 | 19,590 .. 9·698 |
| Auxiliary engines | 1,860 .. 1·164 | 2,280 .. 1·097 | 1,610 .. 1·004 | 2,270 .. 1·123 |
| Total main and aux. | 22,680 .. 14·192 | 22,680 .. 10·904 | 21,860 .. 13·628 | 21,860 .. 10·821 |
| Percentage increase in S.H.P. for same total boiler feed | 30·16 | | 26·07 | |

columns 1 and 2 show the comparison obtained during progressive trials at light draught, while the figures in columns 3 and 4 show a similar comparison under loaded conditions, those in column 3 indicating the results obtained with the original reciprocating engines and those in column 4 the results obtained after the turbine had been installed.

It will be seen from the trial figures that on light draught the increase in shaft horse-power was 30·16 per cent., while under loaded condition the percentage increase was 26·07.

During the trials careful observations were made as to the manœuvring capabilities of the combined installation, and it was found that it could be handled with all the manœuvring facility of a simple reciprocating engine.

Since the vessel was placed on service in the North Atlantic trade in early May of this year she has encountered very severe weather, and the engineers report that the machinery has worked with entire satisfaction and has not given the least trouble.

## Paris Exhibition, Metropolitan Building.

THE only building of engineering interest at the International Colonial Exhibition in Paris is the Metropolitan Palace, which is devoted to French engineering and other industries. It covers an area of about 42,000 square metres, and is probably the largest construction of its kind in France. It is only intended to be a temporary building, and it is noteworthy not only for its design in view of an ephemeral existence, but also for the rapidity with which it was erected. It occupies the site of the old fortifications to the left of the main entrance, and will be pulled down immediately after the close of the Exhibition. The ground on which it is built is sufficiently compact to bear the load of something like 1800 tons on an economical foundation of piles and concrete.

The total length of the building is 1525ft. and the width varies with a maximum of 347ft. on account of the necessity of occupying all the available space on an irregular site. The height to the top of the series of lantern roofs is 118ft. In cross section the roof of the central bay is supported on girder columns 131ft. apart, and stays from the spans abut not only on these columns, but also on others forming the walls 20½ft. away on each side, so that the total width of the bay is 172ft. The stanchions have a cross section of 31½in. by 27in., and they are built of angles 90 mm. wide and 10 mm. thick, stayed transversely with lighter angles and diagonal strips and with plates where they carry longitudinal girders. They are in a series of three steps, and the central span, therefore, takes the smallest load. A noteworthy feature of the design is the elaborate staying with angles and strips in a building which is only destined to stand a little more than a year, while the use, apparently, of only two sizes of angles and one of strip is obviously conducive to economy and will allow of the building being demolished at a minimum of cost. The size of the building is impressive and its lightness striking. It is an excellent example of economy in metallic exhibition construction.

The girders and spans were assembled on the ground and erected with two 5-ton travelling cranes, with radii covering nearly the whole width of the building, except the lower outer annexes, and reaching to a height of 150ft. The erection was entirely completed in three months. The length of the bay itself is 1305ft. It is extended by a frontage which bends round slightly to be in line with the Cité des Informations on the other side of the main entrance. The frontage has a circular tower of reinforced concrete, 262ft. high, surmounted by a lantern. The metallic structure is covered with fibre and plaster, and the upper recessed parts are glazed, while eight raised sections of the roof have glazed sides. The steel construction work was carried out by the Etablissements Baudet, Donon et Roussel, of Paris, and the architect was Monsieur Audoul.

Views of the building during erection are shown on page 120.

## WRECK STATISTICS FOR 1930.

THE statistical summary of ships totally lost, broken up, condemned, &c., recently published by Lloyd's Register, shows that during 1930 the gross reduction in the mercantile marine of the world amounted to 668 ships of 1,313,284 tons, excluding all ships of less than 100 tons. Of the total, 561 ships of 1,232,521 tons were steamers and motor ships, and 107 of 80,763 tons were sailing ships. The reduction compared with 1929 shows a decrease of 230,318 tons—226,144 tons as regards steamers and motor ships and 4174 tons for sailing ships. Tonnage broken up during 1930 amounted to 898,474 as against 987,476 tons in 1929, a decrease of 89,002 tons, and actual casualties were less by 141,316 tons. The tonnage of ships owned in Great Britain and Ireland which were broken up, dismantled, &c., during 1930 amounted to 270,191 tons.

The statistical tables, which have been prepared in such a manner as to facilitate comparison between the principal maritime countries of the world, exhibit interesting data as to the relative frequency of the different kinds of casualty which conclude the existence of ships. Strandings and kindred casualties which are comprised under the term "wrecked" are the most prolific cause of disaster. To such casualties are attributable 56 per cent. of the number of steamers and motor ships lost, and 37·3 per cent. of sailing ships. Cases of abandoned, foundered, and missing ships are, no doubt, frequently more or less similar in the circumstances of loss; and, if they be taken collectively, they comprehend 22 per cent. of steamers and motor ships and 35·8 per cent. of the sailing ships removed from the mercantile marine during 1930, owing to casualty.

A large proportion of the tonnage annually removed from the merchant fleets of the world comes to what may be called a natural end, being broken up, dismantled, condemned, &c., for reasons not known to be consequent upon casualty or stress of weather. During 1930 the ships so broken up, condemned, &c., amounted to no less than 68·9 per cent. of the tonnage of the steamers and motor ships, and 61·8 per cent. of the sailing ships included in the summary.

One of the tables shows the number and tonnage of steamers and motor ships of all nationalities lost through marine and war casualties since 1907, exclusive of ships broken up, condemned, &c., not in consequence of casualty or stress of weather. Excluding the five war years, 1914–18, the average percentage of loss of steamers and motor ships belonging to Great Britain and Ireland during the remaining nineteen years amounts to less than 1 per cent. per annum of the tonnage owned. The world percentage for the year 1930 was 0·59.

THE New International Association for Testing Materials (N.I.A.T.M.), which was formed as a result of meetings in Amsterdam in September, 1927, will hold its first Congress from September 6th to 12th in the buildings of the Swiss Federal Polytechnicum, Zürich. The President is Professor A. Mesnager. The work of the Congress will be in four groups, namely (*a*) Metals, chairman, Dr. W. Rosenhain, late of the National Physical Laboratory; (*b*) Non-metallic Inorganic Materials, chairman, Professor M. Ros, of Zürich; (*c*) Organic Materials, chairman, Professor J. O. Roos, of Stockholm; and (*d*) Questions of General Importance, chairman, Professor W. von Möllendorf, of the Staatliches Materialprüfungsamt, Germany. The proceedings will commence on Sunday evening, September 6th, with a reception in the Zürich Polytechnic, and addresses by the President and others. The sections will meet each day in the Polytechnic, the plenary session taking place on Friday afternoon, September 11th. Visits to works, excursions to places of interest, and various entertainments are being arranged. Particulars of the travelling arrangements and hotel accommodation can be obtained by members affiliated to the British branch of the N.I.A.T.M. from Mr. G. C. Lloyd, 28, Victoria-street, London, S.W. 1. The Autumn Meeting of the Institute of Metals will also take place in Zürich in the week commencing Sunday, September 13th—that is, immediately following the Congress of the N.I.A.T.M.

## Provincial Letters.

### THE MIDLANDS AND STAFFORDSHIRE.

(*From our own Correspondent.*)

**Clearing Up.**

IN Midland and Staffordshire industries preparations have this week been made for the forthcoming holidays. At most of the works there has been some increase in activity, managements being eager to get everything cleared up before the end of the week. Lean order books are the general rule, and in many cases it is likely that the August break will be of an extended character. There is little carry-over of business, and unless substantial orders are received during the vacation the present system of short-time working is likely to continue. The prospects are not held to be reassuring, and in some Midland industries the outlook is considered gloomy. Most industrialists in this area, however, entertain hopes of a general improvement in trade in September. There has been a very small call for iron and steel this week, most manufacturers having sufficient material at hand with which to complete work required before the shops closed down. As almost immediate delivery of fresh supplies is to be had, there is no anxiety as to material with which to reopen the works. There is also little likelihood of any material change in values in the interim. Such is the state of trade in this area that a full week or ten days' cessation of production will not occasion the slightest concern to trade circles.

**Staffordshire Iron.**

Trade flows sluggishly in the Staffordshire finished iron industry, and only a small proportion of the works capacity is employed. Marked bar mills, though better engaged than other branches of the trade, are doing no better than they were. Makers are able to dispose of the bulk of their output at the recognised figure of £12 per ton at makers' works. Competition in the Crown bar department is unabated, and prices vary considerably. They run from £9 5s. to as much as £10 7s. 6d., though it is few firms indeed which can command the latter figure. Producers of strip are receiving small orders, but they complain that business is still very poor, and that they are unable to get more than £10 12s. 6d. per ton delivered for their output. Nut and bolt and fencing bars continue to be quoted £8 7s. 6d. upwards, but there is practically no business being done. The small amount of material being consumed in the Black Country works is for the most part of foreign origin.

**Steel.**

The general condition of the heavy steel industry in Staffordshire remains unsatisfactory. Mills are only working short time, and orders are of very small tonnage. Midland structural engineers are at best moderately engaged, and so keen is competition for the work available that much of it, when secured, gives little hope of a reasonable margin of profit. Prices of finished steel are unchanged. Angles sell at £8 7s. 6d., tees at £9 7s. 6d., joists at £8 15s., and ship, bridge, and tank plates at £8 17s. 6d., less their respective rebates to users confining themselves to British material. There is but a poor call for boiler plates, which are quoted £9 per ton. Small bars are quoted £6 7s. 6d. to £6 10s., when re-rolled from continental material and £7 when all British. Mild steel billets command £5 upward and Staffordshire hoops £9 10s. Birmingham merchants handling continental material are quoting prices slightly lower than those which ruled a week ago, little business is being negotiated, and market levels are difficult to determine.

**Pig Iron.**

There is no change on the week in the conditions ruling in the raw iron industry in the Midlands. It is stated that at one or two furnaces there has been some improvement in the volume of business transacted, and that some reduction of stocks has resulted. Specifications from foundries in this area are all for small tonnages, while forges are calling for only a minimum of material. Selling prices are upheld at the level fixed by the Central Pig Iron Producers' Association, namely, £3 6s. for Derbyshire and North Staffordshire No. 3 foundry, £3 1s. for forge, and £3 2s. 6d. for Northamptonshire foundry, £2 17s. 6d. for forge.

**Galvanised Sheets.**

Keen competition for orders has caused makers of galvanised sheets to cut their prices and values have fallen a further half-a-crown per ton. Sheets of 24 gauge are now to be had at £9 7s. 6d., though some mills require fully £9 10s. Cutting in 30 gauge sheets is even more severe than in 24 gauge. Demand continues to improve, as does the range of overseas markets.

**Coming Amalgamation.**

At the annual meeting of the Horseley Bridge and Engineering Company, in Birmingham, the chairman, Sir Sydney H. H. Henn, dealt at some length with the advantages of amalgamation, and intimated that it was hoped shortly to lay before the shareholders of the company a scheme for the complete merger of their business with that of Thomas Piggott and Co., Ltd., of which firm they acquired control three years ago. It was pointed out that the Horseley Company was at present responsible for the working of four factories—the Horseley works at Tipton, the Hooper-street and Spring-hill works in Birmingham, and the Guest, Keen and Piggotts pipe works at Cardiff. They thought it would be greatly to the advantage of all concerned if their output were concentrated at fewer spots.

**A Successful Conference.**

The conference having as its object the fostering of Black Country trade with South America, to which I referred in my last letter, is reported to have been very

successful. Lord Ednam, who was the principal speaker, dealt with the conditions, needs and possibilities of the market, and pointed out that as a result of the Prince of Wales's visit there was the friendliest possible spirit towards England existing in the South American countries. The conference has undoubtedly served a useful purpose in clearing away some of the local manufacturers' misapprehensions and difficulties, and as it is hoped to establish close touch with the British Chamber of Commerce in the Argentine, excellent results to Black Country industries are anticipated.

**B.I.F.**

Applications for stands at the next British Industries Fair in Birmingham are already rolling in, and despite the fact that the Castle Bromwich buildings are being extended to give a total exhibition area of 250,000 square feet, 80 per cent. of that space has been booked. There seems to be a probability of every available inch of space being taken up shortly, and it is questionable whether latecomers will be able to secure all the space they would like.

**Unemployment.**

Recent statistics show that unemployment in the Midland area has again bounded upward. The small decreases of recent weeks have been set at nought by last week's increase of nearly 10,000. There are now 252,223 wholly unemployed in the division, 155,573 temporarily stopped, and 578 normally in casual employment, making a total of 408,383. The figure is higher by 118,094 than in the corresponding week last year. In the Birmingham area the total of 70,613 is higher than a week ago, but there have been decreases during the week in such important areas as Coventry, Stoke-on-Trent, Nottingham, Leicester, and Cradley Heath. Of the grand total, no fewer than 285,014 are male adults unemployed.

## LANCASHIRE.

*(From our own Correspondents.)*

MANCHESTER.

**Attracting and Financing New Industries.**

WITH the appointment during the last few days of Mr. K. Russell Brady as administrative head of the Lancashire Industrial Development Council, this body may now be regarded as having started its active career. The promoters of the Development Council recognised the improbability of the cotton industry in the future providing a normal outlet for capital and labour, and the primary object is therefore to attract as many new ventures as possible to make up for the Lancashire cotton trade's deficiencies. A suggestion which seems to provide an interesting means to this end has been thrown out this week by Mr. E. Raymond Streat, secretary of the Manchester Chamber of Commerce and a director of the Development Council. This is concerned with the all-important question of finance. His proposal is that well-known Lancashire business men and financiers should co-operate in the formation of a new finance company, tentatively styled the "Lancashire General Industries Investment Corporation," for the express purpose of assisting the development of both existing and new industrial ventures.

**Wielding the "Axe."**

Engineering trade organisations in Lancashire have long been pressing for a drastic revision of municipal and county expenditure, with a view to a reduction of the rates burden. Marked progress in this direction seems now to be assured. The Lancashire County Council is considering a proposal to establish a Co-ordination Committee, an important duty of which would be to scrutinise closely county expenditure from the point of view of necessity, urgency, and commitments authorised or likely to be authorised. Drastic economy proposals, extending over a period of five years, have also been put before the Manchester City Council by the Expenditure Special Committee, and have been adopted by a substantial majority. Certain branches of the engineering trades may suffer in the process of wielding the economy "axe," but the prevailing opinion is that the majority may eventually derive permanent benefit from a lightening of the heavy rates burden.

**Works Managers.**

A Manchester and District Branch of the British Works Managers' Association is to be inaugurated at a meeting and luncheon on August 17th.

**Industrial Results.**

Unsatisfactory trading results are indicated by announcements made by Lancashire engineering firms during the past few days. In the case of Mather and Platt, Ltd., of Newton Heath, Manchester, the interim dividend on the ordinary shares for the half year to the end of June is to be one of 2½ per cent. actual, less tax, compared with interim distributions of 5 per cent., tax free, in each of the previous nine years. Edward Wood and Co., Ltd., constructional engineers, of the Ocean Ironworks, Manchester, are unable to pay a dividend on the ordinary shares for the year to the end of May. In each of the two previous years the distribution was at the rate of 7 per cent. The preference dividend is to be paid as usual. For the year ending March 31st, the operations of Brooks and Doxey, Ltd., textile machinery manufacturers, of West Gorton, Manchester, resulted in a trading loss of £3906, compared with a profit of £2857 in the previous year, and one of £24,307 in 1928–29. The debit balance to be carried forward has been increased to £175,939.

**Non-ferrous Metals.**

Experience on the non-ferrous metals market during the past week, from the point of view of stability, has been disappointing. Notwithstanding a further rather important decline in the tonnage of tin, represented by stocks of the metal in this country, and also reports of increased activity in Welsh tin-plate mills, prices have lost the whole of the previous week's gain and are now back to where they were five weeks ago. The demand for tin this week has been of moderate extent. With regard to copper, stocks are much too heavy in relation to the call for the metal, which has been at a very low ebb this week. Here also the improvement of the previous week has been fully wiped out, and the market has achieved the unfavourable distinction of values being the lowest on record with the tendency at the moment of writing distinctly weak. A quiet demand for lead has been accompanied by a loss on balance of 5s. a ton, although quotations in this section are still appreciably above those ruling about the middle of June. Buying interest in spelter has been very poor, and with no improvement in the statistical position of this metal prices have given way considerably during the week.

**Iron and Steel.**

Seasonal influences are adding to the troubles of the iron and steel trades in Lancashire, and relatively little new business has been placed this week. Foundry iron makers report a definite return to dull conditions, with consumers replacing expired contracts with orders extending over a week or two. Quotations, however, are reasonably steady at 67s. per ton for Derbyshire, Staffordshire, and Cleveland No. 3, 65s. 6d. for Northants, about 87s. 6d. for Scottish, and 81s. for West Coast hematite iron, all delivered equal to Manchester. Poor sales of spot parcels of bar iron are reported on this market, with offers of Lancashire Crown bars at £9 15s. per ton and seconds at about £8 5s. Inactivity in the Lancashire steel-using industries continues to be reflected in the steel market here, where contract commitments are a rarity and current sales are almost wholly a matter of small parcels for near delivery dates. Quotations for boiler plates range from £8 17s. 6d. to £9 per ton according to quantity, with small re-rolled bars at about £6 10s., large diameter bars at £9 7s. 6d., sections at £8 7s. 6d., joists at £8 15s., and general plates at £8 17s. 6d. The demand for imported materials of all kinds has been limited and with a return to easy conditions buyers seem inclined to adopt waiting tactics in the hope of securing lower rates.

BARROW-IN-FURNESS.

**Hematite.**

There is nothing fresh to report about the hematite pig iron trade, which continues to be flat. In some cases stocks are coming down, but this is not due to any improved demand, but to the fact that there has either been a damping down or severe restriction. The ironworks are still idle at Barrow, but it is just possible that they may restart in a few weeks. Generally speaking, the home trade has not been so quiet for a considerable period, and all buyers are keeping down their orders to the lowest amount. If there were more confidence many would now buy, for the price is as low as it can be, and as soon as there is a bigger demand quotations will rise. The foreign trade is dull, and there does not seem much prospect of an improvement in this direction. America is a poor buyer at present. The iron ore trade reflects the state of the iron trade, and apart from the quiet demand locally for native sorts, the business done with Scottish and Midland buyers is poor. Foreign ore is in quiet demand, with imports down considerably. The steel market is dull, and no railway material is being turned out at Barrow, but it is possible that there may be more activity in a month or two, perhaps less. Fuel is not in great demand, and shipping is quiet.

## SHEFFIELD.

*(From our own Correspondent.)*

**Quiet Conditions.**

THE state of limited activity which has characterised most branches of Sheffield trade for some time is now being accentuated by the approach of the holiday season, which has caused the prospects of a revival to recede still further. There will be a good deal of stock-taking by steel consumers during the early part of August, and for this and other reasons the holidays are likely to be longer than usual. In one respect, the coming of the holidays has had a beneficial influence, though it was only temporary. This relates to open-hearth steel, users of which have been laying in extra supplies to cover the stoppage of production, but this increased liveliness has now tapered off and left things much as they were. Very little work is being placed for forward delivery, and the inquiry list is exceptionally poor. It is only with difficulty that a limited number of furnaces are kept in operation. There is no improvement to report in the railway and shipbuilding branches, both of which are very short of work. Deliveries of steel scrap to the furnaces still tend to shrink, and trade is likely to be very slow during the holiday period, unless the steel trade receives an unexpected spurt. The country appears to contain more scrap than it needs, and in some continental countries supplies are accumulating.

**Various Branches.**

A falling off in the demand for stainless steel and its kindred materials, acid-resisting and heat-resisting steel, is reported, though the tonnage being produced is still substantial. There is increasing severity of competition in this branch, alike from home and foreign sources. While the automobile industry continues to take very useful quantities of Sheffield forgings and pressings, springs and special steel, its requirements are considerably below what they were up to two years ago, and several firms are suffering accordingly. Only a moderate amount of trade is coming forward from the home market in engineers' tools and tool steel, while the export side of these branches has fallen away to very small proportions. Some trade from Russia is, however, on hand. One local firm is executing an order from that country for files, said to number 8000 dozens, and there are oddments of work about from the same market. The credit problem is still a handicap to trade with Russia. But for that more orders could be obtained locally. The Russians themselves are now making both files and hack saws. It is reported that the Soviet Government has completed negotiations for the purchase of the s.s. "Dore" from Messrs. Harries Brothers, shipowners, of Swansea, and that the vessel will shortly be transferred to the Mersey, where she will embark a cargo of machinery and technical equipment from Sheffield, destined for Leningrad.

**Hack Saw Progress.**

One of the most progressive Sheffield trades is the manufacture of hack saws, which has made great strides since it was taken up in the city about thirty years ago. The local makers have secured nearly the whole of the home market, which was formerly an American monopoly, and a considerable and increasing business is being done in foreign countries. The sand-blasted high-speed hack saw blade, introduced about four years ago, has proved of great value in connection with the cutting up of metals, and is now a well-established pattern. A new pattern high-speed hack saw blade, known as the "G," has just been brought out by Hacksaws, Ltd., of Sheffield. It has coarse teeth specially suitable for heavy work, and can easily be re-sharpened on any ordinary grinder. The shape of the tooth is known to the workmen as "Jew's Nose." It has a deep gullet, and the angle of the teeth is similar to that of a high-speed turning tool. These points are said to make it ideal for dealing with big sections, and the tool is claimed to be the fastest cutting blade on the market. The design of the tooth has been registered in a number of countries, and licences for the manufacture of the "G" blade have been granted to selected houses.

**Sheffield Official for Baldwins.**

Mr. D. Thomson, for many years with the firm of Brown Bayley's Steel Works, Ltd., Sheffield, has been appointed general manager of the Monmouthshire branch works of Baldwins, Ltd. The vacancy arose through Captain H. Leighton Davies asking to be relieved from the direct management of the works.

**A Veteran and his Successor.**

I announced a few weeks ago the impending retirement of Mr. G. G. Coppel, managing director of J. J. Saville and Co., Ltd., and of William Jessop and Sons, Ltd., of Sheffield. Mr. Coppel, who has been an outstanding figure in the steel trade, on both its commercial and scientific sides, for half a century, was entertained last week-end to a complimentary dinner by the directors, staff, and foremen of Savilles, who also presented him with a sterling silver cigar casket. It was announced that his successor in the two managing directorships will be Mr. Lewis Chapman, who has for many years been associated with the special steel side of Sheffield industry. Mr. Chapman joined Messrs. Saville's staff twenty-five years ago, and became a director three years ago. About the same time he became a director of Jessops, for whom he has since also acted as general manager. In his early career he went through the practical side of crucible steel melting and steel manipulation, and he has travelled extensively all over Europe, and in the United States and Canada, in the interests of both concerns. The two businesses will continue to function separately, each having its own works. Savilles specialise on high-speed and special steels generally and files, while Jessops' main productions are crucible tool steel, fine sheet and strip rolling, and they have a large heavy and light engineering section producing finished crank shafts, ranging in size from aeroplane and automobile engine cranks up to the largest submarine Diesel engine type. Jessops' steel foundry is noted for high grade and intricate steel castings for engineering.

**A Bullion Fusion.**

It is announced that E. W. Oakes and Co., Ltd., of Rockingham-street, Sheffield, and William Turner and Co., Ltd., of Eyre-street, who have for many years traded as refiners and dealers in the precious metals, have amalgamated their bullion businesses, and will in future trade under the style of Oakes, Turner and Co., Ltd., the company being a subsidiary of Johnson, Matthey and Co., Ltd., the well-known bullion merchants of Hatton-garden, London. An efficient plant is being maintained at Eyre-street for the production of gold and silver in all forms and qualities. The plant at the Rockingham-street branch is engaged in the production of rolled, drawn, and pierced wires, and has recently been augmented by the purchase of the business of the late Mr. John Gorrill, formerly carried on at 41, Sidney-street, Sheffield. It is intended in the near future to concentrate all the company's activities at the Eyre-street establishment. The nickel section of Messrs. Turner's business is not included in the fusion, but will be continued under the old title and management.

**Cutlery and Plate Innovations.**

The plate and cutlery trades are not experiencing any summer spurt, and trade in most branches is very slow. Travellers report that dealers are now buying on a very meagre scale, as they have not disposed of the stocks obtained earlier in the year. A fair number of contracts are on hand for hotel and ship equipment, and the coupon trade provides a substantial amount of employment. A new pattern table knife, with a longer handle and a shorter blade than customary, was put on the market earlier in the year by several firms. The design is said to have obtained some popularity in America. There does not appear to have been any great demand for it so far from the British public, but a number of dealers are stocking it, and an order for several thousands of these knives has just been placed locally by Messrs. Lyons. A new form of non-conducting handle for teapots and other vessels containing hot liquids has just been introduced by the Sheffield firm of Towns Patents, of 92, Trafalgar-street. The handle is made of hardened and moulded bakelite, a stronger material than ebony, and is detachable. It

slides into a metal section attached to the vessel, and no heat can pass to the hand when the pot contains boiling liquid. It is considered likely to appeal strongly to proprietors of hotels and cafés, as it meets the need for a teapot with a handle that is always cool. The firm is supplying it complete for attaching to teapots, and it is being taken up by leading silversmiths in the city.

## NORTH OF ENGLAND.

*(From our own Correspondent.)*

### Tees Shipyards Sold.

Two Tees shipyards have just passed into the hands of National Shipbuilders' Security, Ltd., the syndicate which is buying up shipyards all over the country and reselling the sites to other industries. They are Smith's Dock Company's Stockton shipyard and Craig Taylor's shipyard at Stockton, which means the virtual extinction of Stockton as a shipbuilding centre. At present there is only one yard building ships on the Tees—that of the Furness Shipbuilding Company, Ltd., Haverton Hill. Although shipbuilding has been at a low ebb on Tees-side for years, the news that two of the oldest yards on the river are to lose their identity altogether will be a blow to the district. It is a long time since a vessel left the slipways at Craig Taylor's yard. Smith's Dock Company's yard formerly belonged to Ropner and Co., and was taken over to deal with an overflow of work from the South Bank yard. In its hey-day the yard of Craig Taylor's contributed many vessels to the Royal Mail Steamship Line and very frequently turned out vessels up to 7000 tons.

### Cleveland Iron Trade.

The Cleveland pig iron trade presents a cheerless position. Stocks continue to increase slowly but steadily, and they are perhaps as extensive as is desirable, though they are hardly inconveniently heavy. Much of the limited supply of pig iron is absorbed by the needs of producers' own consuming departments, and home sales are almost confined to direct business between ironmasters and consumers. Export demand is still light, but second hands manage to dispose of odd parcels to firms abroad. Cleveland pig iron is offered by makers at specially low prices to consumers in Scotland, but with little success, dealers in cheap overseas products retaining the bulk of the Scottish trade. Purchasing of Midland iron in this district appears to have ceased, but deliveries from that quarter continue in fulfilment of running contracts. For home purposes No. 1 Cleveland foundry iron is 61s., No. 3 G.M.B. 58s. 6d., No. 4 foundry 57s. 6d., and No. 4 forge 57s.

### East Coast Hematite.

The East Coast hematite pig iron trade is hampered by rather heavy stocks, and buyers are very backward, though they admit that a further material fall in values is unlikely. Consumers as a rule are placing orders which are sufficient for present needs only. Makers are doing a small trade with the Sheffield district and the Midlands, and, by severe price-cutting, merchants manage to sell occasional small quantities to overseas firms. Ordinary qualities are quoted at 62s., and No. 1 quality is at a premium of 6d. per ton.

### Ironmaking Materials.

There is little or nothing being done in the foreign ore trade. Consumers have large stocks and good deliveries to take under running contracts. Best Rubio ore is now no more than 14s. 6d. c.i.f. Tees. Good medium blast-furnace coke is plentiful, and can be bought at 15s. for early supply to North-East Coast works, but some sellers will not accept that figure, and have closed their books.

### Manufactured Iron and Steel.

There are no new features of moment in the manufactured iron and steel trade. Orders for nearly all descriptions of material are scarce, and in certain branches work is much needed, but recognised market rates are upheld. Constructional steel departments, however, are well employed.

### The Coal Trade.

Trading in the Northern fuel market during the past few days has been at a disappointing level, and, unfortunately, there is nothing in sight likely to give animation or optimism to the forward position. When approaching a Bank Holiday week-end, past experience has shown that the demand is often keen, and merchants are able to secure terms which give a steadying effect to the market. There has not, however, been any development on this occasion. The pits in all areas are working irregularly, and there is considerable idle time in both Northumberland and Durham. Supplies of Northumberland steam coal are plentiful, and inquiries scarce, with little prospect of any recovery during the next few weeks. Superior brands of steam coal are getting their share of what orders are circulating, but ordinary classes could do with a much bigger demand. Best Northumberland steams are quoted easy at 13s. 6d., and smalls are offered at 8s. 6d. Prime Wear steam are available at 15s., small at 12s., while Tyne prime are steady for large at 12s. 9d. and small at 9s. The gas coal trade has entered upon the quietest period of the year, and demand is slow from all home and continental centres. Whilst the outlook for shipments to Germany is more favourable, those to France have been checked until the licences can be obtained. The French coal import restrictions came into operation this week. It is understood, however, that the French authorities are anxious to minimise interference with existing methods of business and to prevent hardship upon exporters by the licensing decree. All vessels which have been chartered for France with coal before July 16th will be excused licences, but their cargoes will be counted part of the British quota. The general demand for gas coal is disappointing and much below the normal summer demand. Best qualities are offered in substantial quantities at 14s. 6d., and secondary descriptions at 13s. 6d. There is a more active demand for bunker coals, especially the best kinds, prices being steadier in tone at 13s. 6d. to 13s. 9d. Secondary bunkers and coking unscreened are moving slowly at 13s. and 13s. 3d. respectively. There is a good general inquiry for most grades of coke, but merchants fear that there will be no expansion of shipments to France for some time. From other centres a more active market is anticipated. Patent oven coke is steady at 15s. to 16s., and superior foundry coke 17s. to 20s. In gas coke there is a quietly steady demand at 18s.

## SCOTLAND.

*(From our own Correspondent.)*

### Holiday Influences.

HOLIDAY influences still prevail in the steel, iron, and coal trades. Markets are very light, the general inquiry being extremely slow. Owing to the state of order books, there is not likely to be a general restart in the steel and iron trades until Monday, August 3rd, at the earliest.

### Closing of Shale Mines.

By the closing of the shale mines from Saturday last the depression which has hovered over Mid and West Lothian has been considerably deepened. Several villages in the Oakbank district are affected, and of the 3000 inhabitants in the area approximately 85 per cent. are directly concerned, and a further 10 per cent. indirectly. Furthermore, in this area there is no alternative employment, and what was once a prosperous district threatens to become entirely derelict. In recent years the huge increase in the production of petroleum in Persia, Russia, and America has rendered the production of oil from shale an economic impossibility.

### Steel and Iron.

The majority of the steel and iron works remain on holiday until the beginning of next week. Nothing has occurred during the stoppage calculated to inspire confidence in the near future, and in all likelihood order books will not be much heavier as a result of the vacation. Comparatively few inquiries have come to hand, the export markets in particular being disappointing. Prices are all unchanged.

### Coal.

At the moment it appears most probable that a settlement of the colliery wages question will be reached, and a stoppage of work obviated. The miners have been on holiday during the past two weeks, first in the Lothians and then in Lanarkshire and Fifeshire. The mines were reopened in the last two districts on Monday last, but so far the return to work has been very gradual. Outputs therefore are necessarily low, and under the circumstances neither collieries nor exporters are in a position to undertake business. The market consequently is practically at a standstill. Aggregate shipments were 86,956 tons, against 169,117 tons in the preceding week and 87,190 tons in the same week last year. Prices are unchanged.

## WALES AND ADJOINING COUNTIES.

*(From our own Correspondent.)*

### The Coal Trade.

AT one time last week it looked as if shipments would be worse than ever, judging from the number of idle tipping appliances, which on one day touched over fifty; but by the end of the week the number was reduced to thirty-one, and the returns issued by the Great Western Railway Company for the six ports under its control showed that shipments for the week came to 390,600 tons, which compared with 372,800 tons for the preceding week and with 472,108 tons for the corresponding week of last year. The prospects are that the shipments for this week will show a further improvement, since, on Monday, as the result of arrivals of tonnage over the week-end, the number of idle tipping appliances was brought down to twenty-one. Certainly, many collieries looked forward to being busier this week in consequence of tonnage being put on their stems for prompt loading, and a general effort is being made to get away cargoes before the holidays; but it is impossible to say whether the improved activity is likely to be maintained after the vacation, for the foreign demand is very slow, and the bulk of shipments being effected are in respect of contracts fixed up some time ago. No new business of any material account has come on the market of late, and it is not surprising in view of all the conditions prevailing in the export trade of steam coals that the Great Western Railway Company should take steps to economise further. It has been compelled to dispense with the services of between forty and fifty tippers at Cardiff, Penarth and Barry, but it has not made any reductions in the Swansea or Port Talbot area, where coal shipments are more regular, seeing that anthracite coals are shipped principally at those ports.

### Coal Exports to France.

Uneasiness exists regarding the position in view of the operation, from the beginning of this week, of the licensing system for the import of coals into France. So far, few licences have come through, though perhaps it is a little early for the committee appointed to deal with the matter to have got fully into the work. The news came to hand about the middle of last week that vessels chartered to load for France before the 16th inst. could load without licence, but that other cargoes would be charged to the British quota. What has occasioned a good deal of concern to a number of coal exporters and colliery owners is the fact that coals arranged some time ago for shipment to France come within the French scheme. It was thought that contract coals would have been exempted, more especially as in some instances these contracts would have been more advanced but for the fact that exporters here had been requested to defer shipments. It is naturally felt that in the circumstances it is rather unfair that they should now suffer as a consequence. The subject was discussed at a meeting of the South Wales Coal Exporters' Association on Monday, and considerable interest attaches to an interview which Mr. Evan Williams, the Chairman of the Central Council, formed under last year's Coal Mines Act, and Sir Walter Raine, the Chairman of the British Coal Exporters' Association, were to have on Tuesday with M. Laval, the French Premier, in Paris. It is understood that these two gentlemen intended to urge the special claims of this country to special treatment and hopes are entertained that they would be able to obtain, at any rate, some concession in regard to the observance of existing contracts.

### Coalfield Items.

About 1500 men employed at the Wyndham Colliery, Ogmore, were informed at the end of last week that there would be no work for them until after the holidays, in view of the fact that a new pithead framing of steel was being erected. Full work was resumed at the Ocean Western Colliery, Nantymoel, on Monday, after a month's idleness. Fifteen hundred men are employed. There was also a full resumption of work at the Cambrian Colliery, Clydach Vale, on Monday. About 1300 men have been unemployed since June 13th. Six hundred out of the 2000 notices recently issued by the Tredegar Iron and Coal Company to their workmen in the Tredegar district became effective on Saturday last. The remaining 1400 workmen are being continued on daily contracts.

### The Tin-plate Trade.

From to-day (Friday) the annual holiday in the Welsh tin-plate trade begins. Work will be resumed at 6 a.m. on Monday, August 10th.

### Current Business.

The steam coal market all round is quiet and very few fresh orders are coming along for prompt shipment. Practically all classes of coal are freely available for early loading, though dry nuts continue to be a very steady section. In the case of small coals there is no improvement in the demand and supplies standing are enormous. It is computed that standing stocks run to about two million tons, and still collieries are banking supplies in order to free wagons and enable them to supply large and sized coals. Some collieries are experiencing difficulty in finding space near the pits where smalls can be dumped, and are compelled to go further afield, which, of course, means extra expense to them. The inquiry for patent fuel and coke remains without alteration, but pitwood is reported to be a shade steadier.

## LAUNCHES AND TRIAL TRIPS.

CORBIS, twin-screw oil tanker; built by Workman, Clark (1928), Ltd., to the order of the Anglo-Saxon Petroleum Company, Ltd.; dimensions, 465ft. by 62ft. by 34ft.; to carry oil in bulk. Oil engines, Werkspoor type; launch, July 16th.

SIR RICHARD GRENVILLE, twin-screw passenger steamer; built by Earle's Shipbuilding and Engineering Company, Ltd., to the order of the Great Western Railway Company; trial trip, July 16th.

## PERSONAL AND BUSINESS ANNOUNCEMENTS.

HASLAM AND NEWTON, Ltd. (formerly Newton Brothers (Derby), Ltd.) ask us to announce that they have taken over the business of Priestley Patents, Ltd., Leeds, in the manufacture of machines for electric spot, butt and seam welding and machines for rivet and special purpose heating.

THE ENGLISH ELECTRIC COMPANY, Ltd., asks us to announce that it has completed arrangements for the manufacture and marketing of a comprehensive range of mercury rectifiers of the steel tank type, which will be made at Stafford under licence from the Siemens-Schuckertwerke A.G. and with its close technical co-operation.

THE ROYAL AERONAUTICAL SOCIETY.—The "Wilbur Wright" Memorial Lecture is to be delivered by Mr. Glenn L. Martin on Wednesday, September 16th, at 9.15 p.m., in the Science Museum, South Kensington. Mr. Martin will take as his subject "The Development of Aircraft Manufacturing." Following the lecture the Society will hold a conversazione in the Aeronautical Section of the Museum. The date for the lecture has been selected with a view to the fact that on September 12th the Schneider Trophy contest is due to take place. Many foreign aeronautical authorities will be in this country at the time, and they will be specially invited to attend the conversazione. Applications for tickets for admission to the conversazione—5s. each—will be received from non-members. The programme for the Society's sixty-seventh session has now been provisionally arranged. Among many attractive items is included a lecture on October 8th by Professor Piccard, on his famous high-altitude balloon ascent.

LARGE ORDER FOR ELECTRIC PLANT.—In a paragraph in our "Journal" of July 24th we stated that the English Electric Company had been instructed to "proceed with the whole of the electrical equipment" for the South African Iron and Steel Corporation's new plant. We are now asked to say that Asea Electric, Ltd., has been entrusted with the order for the whole of the auxiliary motor equipments, including the motors themselves, the starting and control apparatus and also the cables and low-tension distribution plant. This order has been received from Dorman, Long and Co., Ltd., the main contractors, and approaches £100,000 in value. It includes the supply and complete erection on site, laying and connecting of the cables, and setting to work of the whole equipment embraced in their order. Included in it there are in all some 600 motor equipments, totalling over 10,000 B.H.P. and varying in size from 200 B.H.P. downwards. Among them are some 200 special steel works type motors, designed with split steel casings and constructed to withstand the very heavy duty of up to 1000 operations per hour.

# Current Prices for Metals and Fuels.

## IRON ORE.

| | |
|---|---|
| N.W. COAST— | |
| (1) Native | 16/- to 20/6 |
| (1) Spanish | 14/- |
| N.E. COAST— | |
| Native | 18/- to 21/- |
| Foreign (c.i.f.) | 14/6 |

## PIG IRON.

| | Home. £ s. d. | Export. £ s. d. |
|---|---|---|
| (2) SCOTLAND— | | |
| Hematite | 3 10 0 | — |
| No. 1 Foundry | 3 13 6 | — |
| No. 3 Foundry | 3 11 0 | — |
| N.E. COAST— | | |
| Hematite Mixed Nos. | 3 1 6 | 3 1 6 |
| No. 1 | 3 2 0 | 3 2 0 |
| Cleveland— | | |
| No. 1 | 3 1 0 | 3 1 0 |
| Siliceous Iron | 3 1 0 | 3 1 0 |
| No. 3 G.M.B. | 2 18 6 | 2 18 6 |
| No. 4 Foundry | 2 17 6 | 2 17 6 |
| No. 4 Forge | 2 17 0 | 2 17 0 |
| Mottled | 2 16 6 | 2 16 6 |
| White | 2 16 6 | 2 16 6 |
| MIDLANDS— | | |
| (e) Staffs.— | (*Delivered to Station.*) | |
| All-mine (Cold Blast) | — | — |
| North Staffs. Forge | 3 1 0 | — |
| „ „ Foundry | 3 6 0 | — |
| (e) Northampton— | | |
| Foundry No. 3 | 3 2 6 | — |
| Forge | 2 17 6 | — |
| (e) Derbyshire— | | |
| No. 3 Foundry | 3 6 0 | — |
| Forge | 3 1 0 | — |
| (3) Lincolnshire— | | |
| No. 3 Foundry | — | — |
| No. 4 Forge | — | — |
| Basic | — | — |
| (4) N.W. COAST— N. Lancs. and Cum.— | | |
| Hematite Mixed Nos. | 3 15 6 (a) / 4 0 6 (b) / 4 5 6 (c) | — |

## MANUFACTURED IRON.

| | Home. £ s. d. | Export. £ s. d. |
|---|---|---|
| SCOTLAND— | | |
| Crown Bars | 10 5 0 | 9 15 0 |
| Best | — | — |
| N.E. COAST— | | |
| Iron Rivets | 11 5 0 | — |
| Common Bars | 10 10 0 | — |
| Best Bars | 11 0 0 | — |
| Double Best Bars | 11 10 0 | — |
| Treble Best Bars | 12 0 0 | — |
| LANCS.— | | |
| Crown Bars | 9 15 0 | — |
| Second Quality Bars | 8 5 0 | — |
| Hoops | 12 0 0 | — |
| S. YORKS.— | | |
| Crown Bars | 9 15 0 | — |
| Best Bars | 10 15 0 | — |
| Hoops | 12 0 0 | — |
| MIDLANDS— | | |
| Crown Bars | 9 5 0 to 10 7 6 | — |
| Marked Bars (Staffs.) | 12 0 0 | — |
| Nut and Bolt Bars | 8 7 6 to 9 0 0 | — |
| Gas Tube Strip | 10 12 6 | — |

## STEEL. (d)

| | (6) Home. £ s. d. | (7) Export. £ s. d. |
|---|---|---|
| (5) SCOTLAND— | | |
| Boiler Plates (Marine) | 10 10 0 | 10 10 0 |
| „ „ (Land) | 10 10 0 | 10 0 0 |
| Ship Plates, ½in. and up | 8 15 0 | 7 15 0 |
| Sections | 8 7 6 | 7 7 6 |
| Steel Sheets, ¼in. | 7 10 0 to 7 15 0 | 8 0 0 |
| Sheets (Gal. Cor. 24 B.G.) | 11 7 6 10 0 0 to 10 5 0 | |

## STEEL (*continued*).

| | Home. £ s. d. | Export. £ s. d. |
|---|---|---|
| N.E. COAST— | | |
| Ship Plates | 8 15 0 | 7 15 0 |
| Angles | 8 7 6 | 7 7 6 |
| Boiler Plates (Marine) | 10 10 0 | — |
| „ „ (Land) | 10 0 0 | — |
| Joists | 8 15 0 | 7 7 6 |
| Heavy Rails | 8 10 0 | — |
| Fish-plates | 12 0 0 | — |
| Channels | 10 5 0 | £9 to £9 5s. |
| Hard Billets | 8 2 6 | — |
| Soft Billets | 6 17 6 | — |
| N.W. COAST— | | |
| BARROW— | | |
| Heavy Rails | 8 5 0 | — |
| Light Rails | 8 10 0 to 8 15 0 | — |
| Billets | 6 10 0 to 9 0 0 | — |
| MANCHESTER— | | |
| Bars (Round) | 9 7 6 | — |
| „ (Small Round) | 6 10 0 | — |
| Hoops (Baling) | 10 0 0 | 9 15 0 |
| „ (Soft Steel) | 9 0 0 | 8 15 0 |
| Plates | 8 17 6 to 9 2 6 | — |
| „ (Lancs. Boiler) | 9 0 0 | — |
| SHEFFIELD— | | |
| Siemens Acid Billets | 9 2 6 (basis) | — |
| Hard Basic | 8 2 6 and 8 12 6 | — |
| Intermediate Basic | 6 12 6 and 7 2 6 | — |
| Soft Basic | 6 0 0 | — |
| Hoops | 9 10 0 to 9 15 0 | — |
| Soft Wire Rods | 7 15 0 | — |
| MIDLANDS— | | |
| Small Rolled Bars | 6 7 6 to 7 0 0 | — |
| Billets and Sheet Bars | 5 0 0 to 5 15 0 | — |
| Galv. Sheets, f.o.b. L'pool | 9 7 6 to 10 0 0 | — |
| (2) Staffordshire Hoops | 9 10 0 | — |
| (d) Angles | 8 7 6 | — |
| (d) Joists | 8 15 0 | — |
| (d) Tees | 9 7 6 | — |
| (d) Bridge and Tank Plates | 8 17 6 | — |
| Boiler Plates | 9 0 0 | — |

## NON-FERROUS METALS.

| | |
|---|---|
| SWANSEA— | |
| Tin-plates, I.C., 20 by 14 f.o.b. | 13/6 to 13/9 |
| Block Tin (cash) | 108 15 0 |
| „ (three months) | 110 17 6 |
| Copper (cash) | 32 17 6 |
| „ (three months) | 33 15 0 |
| Spanish Lead (cash) | 12 15 0 |
| „ „ (three months) | 12 11 3 |
| Spelter (cash) | 11 17 6 |
| „ (three months) | 12 3 9 |
| MANCHESTER— | |
| Copper, Best Selected Ingots | 36 10 0 |
| „ Electrolytic | 37 15 0 |
| „ Strong Sheets | 66 0 0 |
| „ Tubes (Basis Price), lb. | 0 0 10½ |
| Brass Tubes (Basis Price), lb. | 0 0 9½ |
| „ Condenser, lb. | 0 0 11½ |
| Lead, English | 14 2 6 |
| „ Foreign | 12 15 0 |
| Spelter | 12 10 0 |
| Aluminium (per ton—raw ingot) | £85 |

## FERRO ALLOYS.

| | Per Ton. | Per Unit. |
|---|---|---|
| Tungsten Metal Powder | 1/11½ per lb. | |
| Ferro Tungsten | 1/8½ per lb | |
| Ferro Chrome, 4 p.c. to 6 p.c. carbon | £21 0 0 | 7/- |
| „ „ 6 p.c. to 8 p.c. | £20 12 6 | 7/- |
| „ „ 8 p.c. to 10 p.c. | £19 17 6 | 7/- |
| „ „ Specially Refined | | |
| „ „ Max. 2 p.c. carbon | £30 0 0 | 10/- |
| „ „ „ 1 p.c. carbon | £34 0 0 | 12/- |
| „ „ „ 0·70 p.c. carbon | £36 0 0 | 14/- |
| „ „ „ carbon free | 9½d. per lb. | |
| Metallic Chromium | 2/7 per lb. | |
| Ferro Manganese (per ton) | £11 0 0 for home | |
| „ „ „ | £11 10 0 for export | |
| „ Silicon, 45 p.c. to 50 p.c. | £10 10 0 scale 5/- per unit | |
| „ „ 75 p.c. | £15 0 0 scale 7/- per unit | |
| „ Vanadium | 12/9 per lb. | |
| „ Molybdenum | 4/2 per lb. | |
| „ Titanium (carbon free) | 9d. per lb. | |
| Nickel (per ton) | £170 | |
| Ferro Cobalt | 8/9 per lb. | |

## FUELS.

### SCOTLAND.

| | Export. |
|---|---|
| LANARKSHIRE— | |
| (f.o.b. Glasgow)—Steam | 13/6 |
| „ „ Ell | 14/- |
| „ „ Splint | 14/6 to 16/- |
| „ „ Trebles | 12/- |
| „ „ Doubles | 11/6 |
| „ „ Singles | 10/6 to 10 9 |
| AYRSHIRE— | |
| (f.o.b. Ports)—Steam | 12/9 |
| „ „ Jewel | 17/- |
| „ „ Trebles | 12/- |
| FIFESHIRE— | |
| (f.o.b. Methil or Burntisland)—Steam | 10/6 to 12/6 |
| Screened Navigation | 16/6 to 17/6 |
| Trebles | 12/- to 13/- |
| Doubles | 11/6 |
| Singles | 10/9 |
| LOTHIANS— | |
| (f.o.b. Leith)—Best Steam | 11/- |
| Secondary Steam | 10/6 |
| Trebles | 12/- |
| Doubles | 12/- |
| Singles | 10/6 to 10/9 |

### ENGLAND.

| | |
|---|---|
| (8) N.W. COAST— | |
| Steams | 20/- |
| Household | 30/- to 51/- |
| Coke | 20/- to 20/6 |
| NORTHUMBERLAND— | |
| Best Steams | 13/6 |
| Second Steams | 12/- |
| Steam Smalls | 7/6 to 8/- |
| Unscreened | 12/6 to 13/- |
| Household | 27/- to 39/- |
| DURHAM— | |
| Best Gas | 14/6 |
| Second | 13/3 to 13/6 |
| Household | 25/- to 37/- |
| Foundry Coke | 24/- |
| SHEFFIELD— | Inland. |
| Best Hand-picked Branch | 24/6 to 25/6 — |
| Derbyshire Best Bright House | 19/- to 20/- — |
| Best House Coal | 18/6 to 20/- — |
| Screened House Coal | 17/- to 18/- — |
| „ „ Nuts | 14/6 to 15/- — |
| Yorkshire Hards | 15/- to 16/6 — |
| Derbyshire Hards | 15/- to 16/6 — |
| Rough Slacks | 8/6 to 9/6 — |
| Nutty Slacks | 6/- to 7/6 — |
| Smalls | 4/- to 5/6 — |
| Blast-furnace Coke (Inland) | 12/3 on rail at ovens |
| Furnace and Foundry Coke (Export), f.o.b. | 13/- to 14/- |

### (9) SOUTH WALES.

| | |
|---|---|
| CARDIFF— | |
| Steam Coals: | |
| Best Smokeless Large | 20/- |
| Second Smokeless Large | 18/9 to 19/9 |
| Best Dry Large | 18/6 to 19/3 |
| Ordinary Dry Large | 17/9 to 18/- |
| Best Black Vein Large | 18/3 to 18/9 |
| Western Valley Large | 18/- to 18/6 |
| Best Eastern Valley Large | 17/9 to 18/- |
| Ordinary Eastern Valley Large | 17/9 to 18/- |
| Best Steam Smalls | 13/6 to 14/- |
| Ordinary Smalls | 11/- to 13/- |
| Washed Nuts | 18/- to 21/- |
| No. 3 Rhondda Large | 19/9 to 20/- |
| „ „ Smalls | 15/- to 16/- |
| No. 2 „ Large | 17/- to 17/3 |
| „ „ Through | 15/6 to 16/- |
| „ „ Smalls | 14/- to 14/3 |
| Foundry Coke (Export) | 22/- to 26/6 |
| Furnace Coke (Export) | 16/6 to 17/6 |
| Patent Fuel | 19/9 to 20/- |
| Pitwood (ex ship) | 21/6 to 22/- |
| SWANSEA— | |
| Anthracite Coals: | |
| Best Big Vein Large | 35/- to 37/6 |
| Seconds | 27/- to 31/6 |
| Red Vein | 22/6 to 27/6 |
| Machine-made Cobbles | 41/6 to 45/- |
| Nuts | 40/- to 40/- |
| Beans | 24/9 to 28/3 |
| Peas | 21/- to 21/9 |
| Breaker Duff | 8/6 to 9/6 |
| Rubbly Culm | 8/6 to 9/- |
| Steam Coals: | |
| Large | 20/- to 20/6 |
| Seconds | 18/- to 20/- |
| Smalls | 11/6 to 13/- |
| Cargo Through | 16/- to 17/6 |

(1) Delivered. (2) Net Makers' Works. (3) f.o.b. Makers' Works, approximate. (4) Delivered Sheffield. (5) Glasgow, Lanarkshire, and Ayrshire. (6) Home Prices—All delivered Glasgow Station. (7) Export Prices—f.o.b. Glasgow. (8) Except where otherwise indicated, coals are per ton at pit for inland and f.o.b. for export, and coke is per ton on rail at ovens and f.o.b. for export. (9) Per ton f.o.b. (a) Delivered Glasgow. (b) Delivered Sheffield. (c) Delivered Birmingham. (d) Rebate: Joists (minimum), 22/6; Ordinary Ship, Bridge, and Tank Plates and Sections, 15/- if home consumers confine purchases from associated British Steel Makers. (e) Delivered Black Country Stations.

# French Engineering Notes.

*(From our own Correspondent in Paris.)*

### Pneumatic-tired Rail Coaches.

SOME months ago reference was made in this column to experiments with pneumatic tires on rail coaches that were being made by Monsieur André Michelin, the founder of the pneumatic tire business at Clermont-Ferrand. Monsieur André Michelin has since died, and the work is being continued by his son, who last week offered for trial four rail motor coaches which were run on the line between Palaiseau and Chartres. The use of pneumatic tires is suggested as a solution of the problem of how to deal with the irregular and insufficient traffic on local lines. The weight of each of the coaches tried was about 175 kilos. per passenger. The vehicles were of two types, one a ten-wheeled Panhard with a 20 horse-power engine and carrying twenty-four passengers, and the other an eight-wheeled coach built for speed with a 46 horse-power Hispano-Suiza engine. The tires, inflated to 85 lb. per square inch, have the appearance of twin tires with the tread fitting the top of the rail. The risk of danger from punctures was shown to be negligible by a tire being purposely punctured while the coach was travelling at 50 miles an hour. As the load was supported by the other nine wheels the effect of the puncture was unnoticed, and the wheel was changed in a few minutes on arrival at the next station. The acceleration was remarkably good, the Panhard coach attaining a speed of 50 miles an hour 600 m. from the start. At that speed it was stopped in 100 m. A maximum speed of 74 miles an hour was obtained on a track on which ordinary trains are not allowed to exceed one-half that speed. It is claimed for pneumatic tires on motor coaches that there is a great saving in fuel consumption, as well as in upkeep of the track, and that such vehicles can safely run at high speeds on worn and defective tracks, as was the case during the demonstration. Smoothness and silence of running are advantages that appeal to users. As it is stated that other similar motor coaches are under construction it is probable that they will be put into service, in which event experience will show whether pneumatic tires can be employed in railway practice.

### Merchant Bar Union.

Joists are controlled on the home market with good effect, but merchant bars have always been left to themselves, and they have suffered more than any other description of rolled iron from the depression. After prolonged negotiations it has been decided to do for merchant bars what has been accomplished with joists, though on a more comprehensive scale, and the union of bar mill owners, which will come into operation to-morrow, provides not only for minimum selling prices, but also for a limitation of output. This will be based on the production of 1928 and of the first ten months of 1929. Selling prices will be fixed by a central organisation. As soon as the union was formed prices were advanced and are now about 70f. a ton above the recent minimum. The rumour of the contemplated advance provoked some active buying, but in the present state of affairs it is doubtful whether this activity will be maintained. Producers will continue to deal directly with their customers, and all transactions will be notified to the central bureau, so that, while prices will be verified, any orders in excess of the quota of production for any firm will be passed on to others. The agreement is experimental and will last for six months.

### The Kembs Power Station.

The construction of the Alsace lateral canal between Kembs and Strasburg as a means of avoiding navigation difficulties on that part of the Rhine is intended also to provide a considerable quantity of energy from the hydro-electric stations to be installed at the locks, and the first section at Kembs, which is well advanced, offers some interest from the fact that the power station will make use of two small lakes at different altitudes for an accumulation of energy during periods when the plant is running under light loads. Those pieces of water are the Lac Blanc and the Lac Noir, on each side of a narrow part of the Vosges chain. The difference of altitude is 125 m. They are being connected by a tunnel which is nearly horizontal for the greater part of its length and is then continued by an inclined tunnel to another short horizontal tunnel to the outlet. The volume of water that can be delivered from one side to the other is about 2,000,000 cubic metres. The Kembs station will pump water from the Lac Noir to Lac Blanc when it is running light, and the power station at Lac Noir will provide a supplement to Kembs when it is dealing with peak loads.

### A Big Suspension Bridge.

The Compagnie Fives-Lille is completing a suspension bridge across the river Durance at Cavaillon (Vaucluse), which, having a length of 1016ft., is the longest of the kind in the country. It replaces another bridge that was suspended from piers in the bed of the river, and as the Durance is a raging torrent at certain seasons the bridge was not considered safe. Other piers of reinforced concrete, 137ft. high, were erected on the banks. The old bridge platform was raised 5ft. and suspended from cables run from the new piers to allow of traffic being continued while the new bridge was constructed underneath. The new bridge is of reinforced concrete on two deep iron girders suspended by thirty-two cables, each of 100 mm. diameter. The width of the bridge is 26ft.

### Electric Omnibuses.

Lyons is the only large town which is employing electric omnibuses, and although there has been some criticism of the cost and alleged difficulties with storage batteries, the system is being extended to the suburbs, for which purpose tenders have been invited for the supply of twenty-eight electric omnibuses. So far as the cost is concerned, it is expected that it will be greatly reduced by the supply of energy from the big refuse incineration plant which is being installed by the German firm of B.A.M.A.G. The economy resulting from the use of this energy for recharging the batteries of public service vehicles was one of the reasons for selecting the system.

# British Patent Specifications.

*When an invention is communicated from abroad the name and address of the communicator are printed in italics.*

*When an abridgment is not illustrated the Specification is without drawings.*

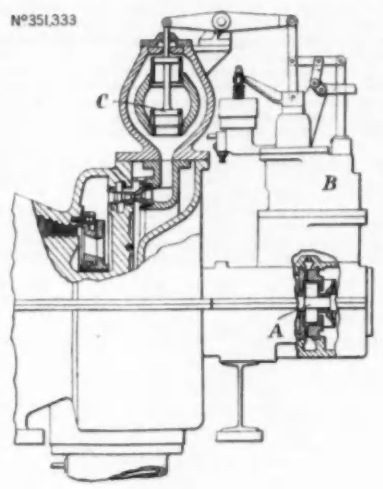
*Copies of Specifications may be obtained at the Patent Office, Sale Branch, 25, Southampton-buildings, Chancery-lane, W.C., at 1s. each.*

*The date first given is the date of application; the second date, at the end of the abridgment, is the date of the acceptance of the complete Specification.*

### TURBINE MACHINERY.

351,333. September 10th, 1930.—SPEED GOVERNING MECHANISM, The Westinghouse Electric and Manufacturing Company, East Pittsburg, Pennsylvania.

This system of governing is said to be capable of maintaining a constant speed regardless of the load on the turbine. It

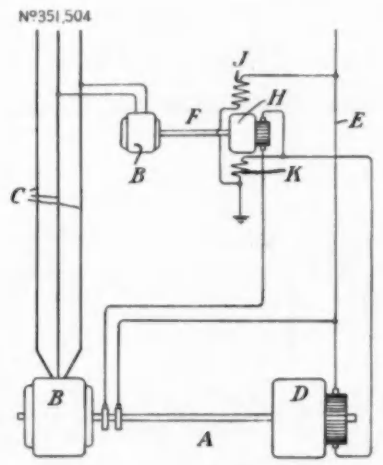



depends for its action on a pump impeller A on the main spindle of the turbine, which supplies oil under pressure to a servo-motor B that operates the steam throttle valve C. The specification describes and illustrates the servo-motor, which is complicated.—*June 25th*, 1931.

### DYNAMOS AND MOTORS.

351,504. January 24th, 1930.—POWER FACTOR REGULATING SYSTEMS, *The British Thomson-Houston Company, Ltd., Crown House, Aldwych, London, W.C. 2.*

This invention relates to regulating systems and particularly to an arrangement for controlling the excitation of a synchronous machine, so as to regulate its power factor when the load on the machine varies. A represents a motor generator set comprising a synchronous motor B connected to an A.C. supply circuit C, and a D.C. generator D connected to a D.C. circuit E, one side of which is connected to earth. The field winding of the motor B is connected across the terminals of the generator D. In order to regulate the power factor of the motor B as its load varies, the inventors provide an auxiliary motor generator set F, comprising an A.C. motor supplied from the A.C. circuit C, and a D.C. machine H, which is connected in series with the motor field winding connected across the generator D. The auxiliary regulating machine H is provided with a field winding J, which is connected across the terminals of the gene-

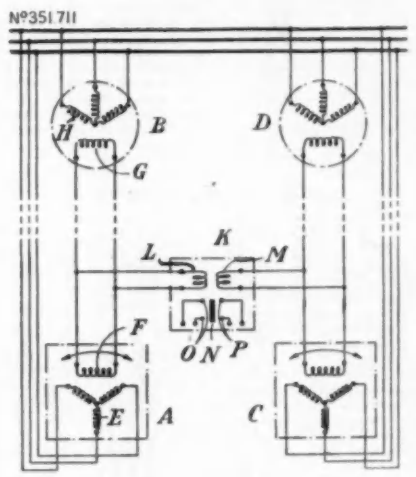



rator D, so that it is energised in response to the voltage of that machine. The regulating machine H also has a field winding K, which is connected in any suitable manner so as to be responsive to the current output of the generator D. As shown, the winding K is connected directly in series with the D.C. circuit E. The windings J and K are arranged in any suitable manner, so that the excitation of the motor B is increased as the generator load current increases. This result may be obtained by arranging the field winding K so that the flux produced by the current flowing through the winding is in a direction to produce a voltage across the brushes of the regulating machine H, which is in the same direction as the voltage of the generator D, and by having the winding J arranged so that it either aids or opposes the winding K. Preferably, the windings J and K are arranged differentially and so designed that the ampère turns of the winding J exceed the ampère turns of the winding K at light loads, and the ampère turns of the winding K exceed the ampère turns of the winding J at heavy loads. With such an arrangement the voltage of the regulating machine H opposes the voltage of the generator D at light loads. As the generator current increases, the opposing voltage of the machine H decreases to zero and then builds up in a direction to aid the generator voltage in supplying exciting current to the motor field winding. In the event of a failure on the part of the auxiliary regulating machine, the main motor-generator set can be maintained in operation without power factor regulation.—*June 24th*, 1931.

### TRANSFORMERS AND CONVERTERS.

351,711. June 2nd, 1930.—CONTROL OF ELECTRIC TRANSFORMERS WITH ON-LOAD TAP CHANGING GEAR, the English Electric Company, Ltd., 28, Kingsway, London, W.C. 2, and Alfred Reginald Blandford, of Siemens Works, Stafford.

The main object of this invention is to provide improved means whereby, in the event of the failure of a tap changer to operate, any tap changers which are leading are automatically brought back into step. For each transformer there is a phase shifter and a tap position indicator, represented respectively by A, B, for one transformer, and C, D for the other. The phase shifter A comprises a three-phase stationary winding E fed from supply mains, which may be the network supplying the transformers, or an auxiliary source, and a moving winding F inductively related to the winding E. The winding F is mechanically-coupled to the tap-changing mechanism—not shown—and moves therewith to a number of angular positions with respect to the winding E, each position corresponding to a tap position. The tap position indicator B is similar in construction to an ordinary power factor indicator, and comprises a fixed winding G electrically-connected in a closed circuit with the winding F through pilot wires, a fixed winding H supplied from the same source as the winding E, and, therefore, in phase with the latter, and a moving element—not shown—which takes up a position in accordance with the difference in phase between the currents in the windings G and H. The moving element operates a pointer, and the latter will thus move to any one of a number of positions corresponding to the angular position of the winding F. An ordinary power factor meter may be adapted as the position indicator merely by the substitution of numbered positions for the usual scale. A phase difference relay K is connected between the indicators, and for every additional transformer used another

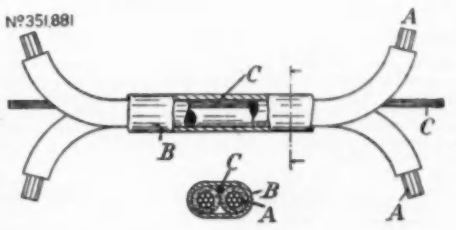



phase relay is placed between its indicator and that of the preceding one. The phase relay K is provided with a winding L connected across the pilot wires between the devices A, B, and a winding M is connected across the pilot wires of the next control apparatus. The windings L, M act on a moving armature, which operates a contact member N arranged normally between pairs of contacts O, P. As the relay windings are in parallel with the windings of the tap position indicators, they will be supplied with current in phase with that of the phase shifter moving windings, and hence in phase with each other if the two tap changers are in the same position, but out of phase if the tap changers are on different taps. If the windings L, M are out of phase, contacts O or P will be closed, according to which phase leads. On the assumption that the tap changing mechanism connected to A is used as a master control, contact P may be arranged to close the circuit of apparatus for moving this tap changer downwards after a time lag and for moving the tap changer connected to C upwards. Contacts O will then be similarly connected for moving the A changer upwards and the C changer downwards. If now, the changer A is moved up one tap, contacts O will close and C will move up one tap. When C has moved up, the windings L and M will be in phase and contacts P will open. In a similar manner, the phase relay K will control the operation of all further tap changers. Should C fail to move up within a predetermined time, the contacts P—remaining closed—will bring A back, when L and M will again be in phase and contacts P will be opened. To prevent hunting by the above operation, a time lag is employed on the returning apparatus for A. In the same manner contacts O are used when the master tap-changer connected to A is being stepped in the opposite direction.—*July 2nd*, 1931.

### TRANSMISSION OF POWER.

351,881. November 8th, 1930.—ELECTRIC CABLES, William Brown, of 89, Douglas-street, Glasgow.

This invention relates to electric cables of the type comprising an insulated core or cores enclosed in a metallic sheath and incorporating a separate earthing conductor which is in elec-

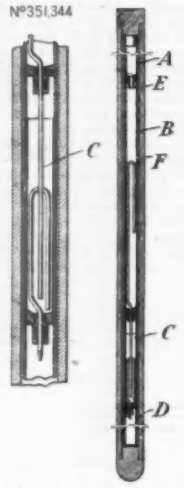



trical contact with the sheath. In connection with cables of this type, it has been proposed to employ an earthing conductor comprising a solid metallic wire or strip, and it has also been proposed to employ an earthing conductor constituted by metalised fibre. According to this invention the cable comprises insulated cores A enclosed in a metallic sheath B, and incorporat-

ing a separate earthing conductor C, which is in electrical contact with the sheath. The earthing conductor is constituted by stranded wire of which the individual strands are in electrical contact with the metallic sheath B. It will be seen that, by virtue of the arrangement described, the liability towards a complete break in the earthing conductor is lessened since more than one strand of the conductor C must be broken before the continuity of the conductor C is affected. Also, it will be seen that the conductor C is capable of entering into effective electrical contact with the sheath B, where the convolutions of the strands touch the sheath.—*July 2nd*, 1931.

## MEASURING AND TESTING INSTRUMENTS.

351,344. September 19th, 1930.—WELL SURVEYING DEVICES, *L. Mellersh-Jackson*, 28, *Southampton-buildings, Chancery-lane, London, W.C.* 2.




This instrument is put forward as being an improvement on the familiar glass bottle and hydrofluoric acid principle, in that a record of the inclination of a bore-hole can be made with a minimum interference of the drilling operation. It comprises a substantial iron casing of hydraulic pipe, and a brass inner part. This brass part is divided into four sections A B C D by intervening plugs. The record is made by marking, with a liquid dye, a "water-line" on a piece of paper slipped into the section C. The upper section A is first filled with the dye, which starts to trickle through into the section B through the plug E. The orifice is, however, chosen to suit the time it will take to lower the instrument. When sufficient dye has flowed into B to immerse the syphon F it is syphoned over into C and marks the paper with a water line. The dye is, however, immediately syphoned off again into D, so that the record is not interfered with by subsequent movement of the instrument.—*June 25th*, 1931.

## MINING MACHINERY.

350,544. March 30th, 1930.—ROCK DRILLING, W. R. Macdonald, 99, Holland-road, Kensington, London, W. 14.

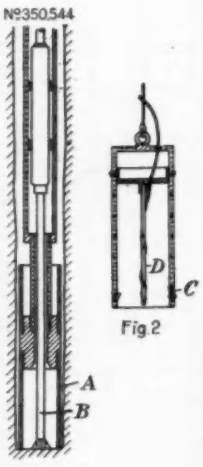


Fig.2

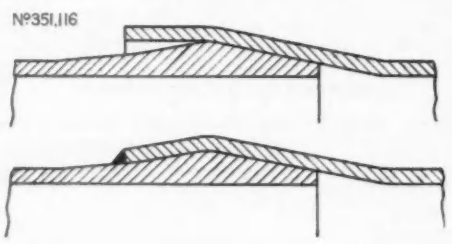
Fig.1.

The inventor proposes to reduce the labour necessary to drill deep well holes by making an annular cut with a rotary tool and simultaneously making a central pilot hole with a percussive drill. A charge of dynamite is then detonated in the bottom of the hole and breaks off the core, which is raised by prongs on a baling device. The illustrations show in Fig. 1 the annular cutter A and the pilot drill B. In Fig. 2 the baler is shown with the catches C for lifting the core and a holder D for the explosive charge.—*June 15th*, 1931.

## MISCELLANEOUS.

351,116. April 2nd, 1930.—PIPE JOINTS, *W. W. Triggs*, 57 *and* 58, *Lincoln's Inn-fields, London, W.C.* 2.

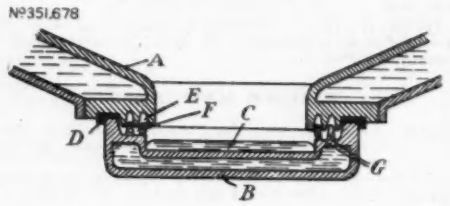
It is the object of this invention to provide a pipe joint which not only is of exceptional strength, but also offers advantages in connection with certain kinds of uses, such, for example, in the mining industry. The joint between the two pipes is made in such a way that the end of the one pipe, which is thickened so that its surface has the shape of two cones placed with their




bases together, is introduced into the widened end of the other pipe, after which this widened end, after being heated, is turned down on to the inner pipe and is shrunk on to the latter so that, on account of the shrinking forces which arise, it bears tightly against the inner pipe. Finally the two pipes are welded together at the internal and external ends or at one of the two ends.—*June 25th*, 1931.

351,678. May 20th, 1930.—MERCURY VAPOUR RECTIFIERS, Aktiengesellschaft Brown, Boveri et Cie., of Baden, Switzerland.

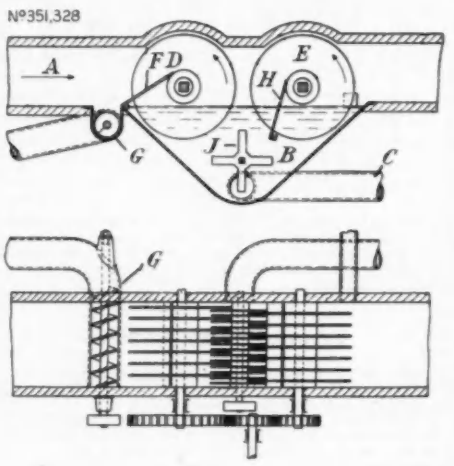
In mercury vapour rectifiers having a metal casing, the cathode is generally electrically insulated from the rectifier casing. With the constant increase in the output of rectifiers the question of insulation for the cathode becomes increasingly difficult. The invention consists in a cathode device for mercury vapour rectifiers having a metal mercury container which is fixed to the rectifier casing so as to be insulated from it and sealed with respect to it. A is the lower part of a rectifier casing. B is the cathode vessel containing the cathode mercury C. Electric insulation and sealing is effected by the intermediate member D, which may consist of a flexible insulating material. Thermal protection against direct contact with the cathode spot and with the mercury vapour is provided by the labyrinth F, which is formed by the concentric gutters E in the bottom part of the rectifier casing, and in the upper sealing surface of the cathode vessel B. This arrangement enables the insulating material D to be kept cool continuously by the cooling water circulating




in the cathode vessel and in the double-walled rectifier casing, and by the hot mercury vapour being forced to condense in the labyrinth E. In order that the mercury condensate dropping off the gutters shall not cause a short circuit between the casing and the cathode, the vertical clearance between the inter-engaging gutters E is made as great as possible. The mercury condensate forming in the gutters E can be easily returned to the cathode B through transverse holes G.—*July 2nd*, 1931.

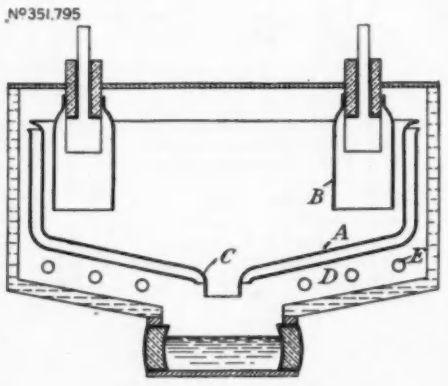
351,328. September 3rd, 1930.—APPARATUS FOR CONCENTRATING SLUDGE, *L. Mellersh-Jackson*, 28, *Southampton-buildings, Chancery-lane, London, W.C.* 2.

This apparatus is intended, primarily, for the thickening of cement slurry on its way to the calcining furnace by means of the heat of the waste gases. The hot waste gases pass along the conduit A in the direction of the arrow, while the slurry is supplied to the well B by the pipe C. Dipping into the well there are two sets of discs D, E, which are rotated against the direction of flow of the gases. These discs pick up the slurry, which is dried by the hot waste gases and, in the case of the discs D, the dried cake is scraped off by the scrapers F and taken away by the conveyor G. The discs E are comparatively ineffective, so the thickened slurry is returned to the well by the scrapers H. A paddle J is used to keep the slurry agitated.—*June 25th*, 1931.




351,795. August 6th, 1930.—METAL-VAPOUR RECTIFIERS, Maschinenfabrik Oerlikon, of Oerlikon, near Zürich, Switzerland.

The guide for the arc of the rectifier built in accordance with this invention consists of a double-walled screen A, which surrounds all the anodes and the anode screens B at the top, and tapers out into a cylindrical tube C towards the cathode. For properly conducting the luminous arc, it is important for the diameter of the tubular opening C to be small in comparison with the diameter of the mercury cathode, since it is only by




its means that the major portion of the mercury vapour can be diverted laterally into the condensation chamber D below the anodes. For the more intensive cooling, a system of tubes E is provided. The double walls of the arc guide A also serve to improve the cooling effect by lessening the transmission of heat from the hot anodes to the condensation chamber D. Furthermore, the condensation chamber and, in particular, the passage from the cathode chamber to the condensation chamber, are designed so as to produce the most favourable suction effect by the condensation chamber.—*July 2nd*, 1931.

## Forthcoming Engagements.

*Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of its insertion, the necessary information should reach this office on, or before, the morning of the Wednesday of the week preceding the meetings. In all cases the* TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

THURSDAY TO SATURDAY, SEPTEMBER 3RD TO 12TH.

"MODEL ENGINEER" EXHIBITION.—Royal Horticultural Hall, Westminster, S.W. 1. Daily.

SUNDAY TO SATURDAY, SEPTEMBER 6TH TO 12TH.

INTERNATIONAL ASSOCIATION FOR TESTING MATERIALS.—Congress at Zürich.

THURSDAY TO SATURDAY, SEPTEMBER 10TH TO 26TH.

SHIPPING, ENGINEERING AND MACHINERY EXHIBITION.—Olympia, W. Daily, 11 a.m. to 9 p.m.

SATURDAY TO WEDNESDAY, SEPTEMBER 12TH TO 16TH.

INTERNATIONAL FOUNDRY CONGRESS.—Milan.

SATURDAY TO SUNDAY, SEPTEMBER 12TH TO 27TH.

INTERNATIONAL FOUNDRY EXHIBITION.—At Milan.

SUNDAY TO FRIDAY, SEPTEMBER 13TH TO 18TH.

INSTITUTE OF METALS.—Autumn meeting at Zürich. For programme see page 21.

FRIDAY TO SUNDAY, SEPTEMBER 18TH TO 20TH.

NATIONAL SMOKE ABATEMENT SOCIETY.—Annual Conference at Liverpool.

TUESDAY TO FRIDAY, SEPTEMBER 29TH TO OCTOBER 2ND.

IRON AND STEEL INSTITUTE.—Autumn Meeting at Swansea. For programme see page 105.

"THE disadvantages at which British merchants and manufacturers are placed as compared with those of continental countries—greater freights, high wages in industry, Yugoslav unfamiliarity with the British market, and the English language—have been dwelt on all too often," says a memorandum on the Economic Position in Yugoslavia, recently issued by the Department of Overseas Trade. "It is late in the day and there are many difficulties to contend with, but it is not yet too late, provided more adaptability is shown, for British merchants and manufacturers to obtain a considerable share of this market. There have recently been welcome signs that firms whose trade with India and China is being withdrawn are turning their attention to Yugoslavia. The most important openings are likely to be found in connection with the sale of machinery and equipment of all kinds."

"INDUSTRIA BRITANNICA."—We desire to congratulate Benn Brothers, Ltd., on the enterprise they have shown by the establishment of a monthly journal devoted simply and solely to the encouragement of trade between this country and the seventeen Spanish-speaking countries of South America. *Industria Britannica*, of which the first number is in our hands, is, in the words of the publishers, a "permanent shop window for British products." It is printed from cover to cover in Spanish, and many of the greater industries of this country are represented in the advertisements, whilst the editorial contents lay before the American buyer particulars of the latest developments of British trade. We trust the words of the Prince of Wales, who has honoured the new paper with a Foreword, that "it will provide an opportunity of drawing closer the friendly trading bonds which have united Great Britain and the South American Republics for so many years, and which were never firmer than they are to-day," may find justification in the prolonged success of the journal.

THE VULCAN FOUNDRY COMPANY, LTD.—To commemorate a century of locomotive building, the Vulcan Foundry Company, Ltd., of Newton-le-Willows, Lancashire, has just issued an attractive volume partly devoted to a history of the firm and partly to a very fully illustrated account of the locomotives it has built since its first engine, the well-known "Tayleur," was completed in 1831. The firm was established in the preceding year for the manufacture of steam engines, sugar mills, boilers, &c., and its association with locomotives came about through the wish of Robert Stephenson to carry on business near Liverpool. By an agreement with his Newcastle firm he was permitted to take an interest in any firm that did not include the name of "Stephenson" in its title, and his interest was to be less than that he held in the Newcastle firm. In the agreement Tayleur and Co. is specifically mentioned. Robert Stephenson remained with the firm until his appointment as engineer-in-chief to the London and Birmingham Railway. Amongst other famous men connected with the Vulcan Foundry was Sir Daniel Gooch, who seems to have gone there as an improver, and Mr. Henry Dübs, who later founded the Queen's Park Locomotive Works in Glasgow. In the hundred years of its existence the firm has built locomotives for most, if not all, the great railways of the world, and at one time made iron tea-clippers, but its most notable undertaking—apart from locomotives—was the construction of a great deal of the work for the Conway and Britannia tubular bridges. The works, from small beginnings, now occupy 87 acres of ground and are almost wholly devoted to locomotive building.

TWO HUNDRED YEARS IN THE COAL TRADE.—There is always something fascinating about old "houses." They carry the mind back to a period when things were not as they now are and when the individuality of the men who made them was not swamped by rationalisation. Of such "houses" "Charringtons," the coal merchants, is one. It began just two hundred years ago, when Joseph Wright came from Newcastle and began trading in sea-borne coal in Lower Thames-street. Its name has been altered from time to time in consonance with a complicated "family tree," and now is Charrington, Gardner, Locket and Co., Ltd., but through all its vicissitudes it has remained the same firm. Its story is told delightfully by Bernard Darwin in an admirably illustrated brochure which has been issued to celebrate the bicentenary of its foundation. The story is full or interesting touches, but none more so than the adventure, as it seemed then, of the search for Welsh coal in 1839. The Lockets were the heroes of that enterprise, and it was the second George of that name who, with others, sank many still famous Welsh pits. The Gardners come into the picture as lightermen. They were dairy farmers in Mile End and Bethnal Green, but when the Regent's Canal was pushed through their property they very prudently built some barges and added the business of carrying goods to that of milking cows. Ultimately the Gardners joined the Lockets, and when in 1922 they amalgamated with the once very familiar Charrington, Sells, Dale and Co., the great company, as it now is, was constituted. It is a complex history of business amalgamation, but Mr. Darwin has succeeded in maintaining interest throughout, and the portraits and reproductions of ancient and modern pictures complete a very attractive volume.